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UNITED STATES
DEPARTMENT OF AGRICULTURE.
SPECIAL REPORT—No. 28.

REPORT

ON THE

CULTURE OF THE SUGAR BEET

AND THE

MANUFACTURE OF SUGAR THEREFROM

IN

FRANCE AND THE UNITED STATES.

PREPARED UNDER THE DIRECTION OF
HON. WM. G. LEDUC,
COMMISSIONER OF AGRICULTURE,
BY
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Superintendent of Agriculture in the United States Section, and Agent and Representative of the United States Department of Agriculture at the Paris Exposition of 1878.

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To the House of Representatives:

In reply to a resolution of the House of Representatives of the 21st instant, requesting the Commissioner of Agriculture to furnish "all information he may have in his possession bearing upon the culture of the sugar beet," &c., the accompanying letter and report received from the Commissioner of Agriculture for this purpose are herewith transmitted.

R. B. HAYES.

EXECUTIVE MANSION, *January* 26, 1880.

DEPARTMENT OF AGRICULTURE,
Washington, D. C., January 22, 1880.

SIR: I have the honor to transmit herewith a report upon the culture of the sugar beet and the manufacture of beet-root sugar in France prepared by Dr. Wm. McMurtrie, agent and representative of this department at the late Paris Exposition of 1878, called for by resolution of the House of Representatives January 21, 1880.

It has been a leading feature of the policy of my administration of this department to determine all the sources of cane sugar available for utilization in this country, and it was believed that the sugar beet, which has constituted so important a part of the basis of the national wealth in France and Germany, might be of value for the production of this necessary staple in the United States.

The presence of our agent and representative in France during the course of the year 1878 was considered a favorable opportunity to secure full information concerning the methods of culture and manufacture followed with so much of success in that country, and he was therefore directed to make a thorough study of the subject and report upon it to this department. Availing himself of the assistance afforded by his official connections and his personal acquaintances among those engaged in the prosecution of the industry, he was able to collect the facts and figures which form the matter of the accompanying report, and which, being the latest information available and describing all the later improvements introduced into the culture and manufacture, cannot fail to be of interest and value to all to whom the report may come, and especially to those who may be particularly interested in the immediate introduction of the industry in the United States.

Very respectfully,

WM. G. LE DUC,
Commissioner of Agriculture.

To the PRESIDENT.

LETTER OF TRANSMITTAL.

WASHINGTON, D. C., *November* 1, 1879.

SIR: In compliance with your instructions, embodied with others in the letter accompanying my commission as agent and representative of the Department of Agriculture at the late Paris Exposition of 1878, directing me to make a study of and report upon the culture of the sugar beet and the extraction of sugar therefrom, I have the honor to submit the following report:

I have prefaced this report with a discussion of the history of the industry, embracing Margraff's discovery of the presence of cane sugar in the root, Achard's enterprising efforts at its culture and the extraction of sugar from it in an industrial way, and the substantial encouragement afforded by Napoleon I, which gave to the industry such an impetus that, in spite of the reverses and unfavorable conditions to which it was subject, it ultimately became an established fact; for thoughthis ground has been gone over by former writers upon the subject in the publications of the Department of Agriculture, it has not been completely covered, doubtless from the fact that they did not have access to the official publications and State papers bearing upon the subject which in this connection it has been my duty and pleasure to consult.

But, while I attach importance to the value of this branch of the subject, my object shall be in this work more particularly to describe the present condition of the industry in France, the improvements that have been effected in the methods of culture and modes of extracting the sugar, and the influences which may modify or destroy the possibilities of successful work. It is only from the experience gained in older countries, after long years of varied success and adversity that we must estimate the probabilities of the successful and profitable manipulation of this valuable crop in the United States.

The points herein considered may be summed up as follows:

1. History.
2. Statistics.
3. Meteorology: Conditions in the beet-growing districts of Europe, and comparison of these conditions with those of different sections of the United States; limits of conditions which govern the extension of the culture.
4. Varieties of beets grown in France; selection of seed and methods employed.

5. Culture: Soil required; physical qualities and chemical composition. Fertilizers: What, when, and how to apply; influence upon the composition and value of the crop. Preparation of the soil. Planting: Time, methods, and apparatus employed; distance between plants, and its influence upon the quantity and quality of the crop. Care to be given crop during growth. Harvesting and storing.

6. Social conditions affecting the culture: Relations between growers and laborers, and between growers and manufacturers.

7. Extraction of sugar: Later improvements in the methods employed.

8. Duties imposed and taxes collected.

9. Importance of the crop in France, and its influence upon other cultures and economies. Conclusion.

It is to be regretted that the time and means at my disposal, and the press of other duties imposed upon me in my relations with the late Universal Exposition, did not admit of a more extended and careful study of this important industry while in France; and any defects that may be noted herein must be referred to these causes. Most of the information I was able to obtain was secured at odd times when my duties at the Exposition would admit of it, and from such publications as I could collect.

There are some points in connection with this subject which are worthy of more thorough examination than has been possible in this work, and among these may be mentioned the meteorological or climatic conditions which may govern the extension of the culture into new sections—conditions, the important influence of which will be clearly manifest in the abstracts of records herein presented—and concerning the deficiency of our recorded knowledge of which, for this country we may not refrain from expressing regret. Study in this direction could not, I firmly believe, fail to be rewarded by results of a character most valuable to our people who may contemplate an attempt at the culture of the crop in the United States.

Respectfully submitted.

WM. McMURTRIE.

Hon. Wm. G. Le Duc,
Commissioner of Agriculture.

ERRATA.

On page 31, in table of statistics, under head of "Manufacture of indigenous sugar," place first line of figures opposite "Aisne" instead of "Ain."

On page 135, in table under "Number of acres sown in beets"—

Instead of 748.98, read 7,489.8.

Instead of 1,214.57, read 12,145.7.

Instead of 1,457.49, read 14,574.9.

Instead of 1,659.91, read 16,599.1.

Instead of 1,497.97, read 14,979.7.

Instead of 1,457.49, read 14,574.9.

Instead of 1,659.91, read 16,599.1.

In Appendix A, plate xviii, instead of "Manull" read "Manuel."

In Table B, page 264, under "Yield per acre," opposite numbers 21, 22, 23, 24, and 25 of the first column, respectively—

Instead of 18, read 15.

Instead of 10, read 18.

Instead of 13, read 10.

Instead of 18, read 13.

Instead of 15, read 18.

On page 266, under "Value of crop, at $5 per ton," top of column, instead of "$80," read "$150."

REPORT

ON

THE SUGAR BEET IN FRANCE AND THE UNITED STATES.

CHAPTER I.

THE EARLY HISTORY OF THE SUGAR BEET AND THE MANUFACTURE OF SUGAR THEREFROM.

It is difficult to trace the exact origin of this plant, which has become of so much interest and value in Europe, and is not only of national but also of continental importance to the people of the other side of the Atlantic. Its antiquity finds evidence in the fact that Theophrastus described two varieties: the deep-red, and the white beet. Olivier de Serres, in his writings in 1590, makes mention only of the red beet, and states that it had not long been introduced into Europe, and says that "the juice yielded on boiling is similar to sugar sirup." This variety was introduced in England in 1548, but the white variety was not known until 1570.

According to the Abbé Rosier, four varieties were already known in 1782, the small and large red, the yellow, and the white. The variety known as *disette*, and which is still grown in France for feeding purposes, was believed to have originated in Germany. It was brought into notice by Vilmorin, the ancestor of the present head of the great seed house of Vilmorin, Andrieux & Co., who died in 1804, and was introduced by Perkins into England in 1786.

The root does not seem to have been considered as having an industrial value, and was cultivated only for the table or for cattle food until 1747, when Margraff, a member of the Berlin Academy of Sciences, believing sugar to be a regular constituent of plants other than the sugar-cane, made examination of different varieties of vegetables, and succeeded in separating from several kinds varying quantities of crystallizable sugar. His method of research consisted in cutting the material to be examined into thin slices, rapidly drying it, reducing to fine powder, and exhausting with diluted alcohol. The results of his researches were announced in a memoir read before the Berlin Academy of Sciences, in the year above mentioned. Of all the plants examined, he found the beet to be the richest in sugar, and believing that Europe

would find in this root the basis of an immense industry, he urged the importance of his discovery upon the Academy, hoping to see valuable and practical results follow it. But he was not destined to see his hopes fulfilled. His methods of work, which were at best imperfect, were of a nature to succeed only in the laboratory, and the prices of colonial sugars were so low as to render competition by the products from a new and untried source out of the question.

This important discovery, therefore, remained dormant for nearly half a century, when one of Margraff's pupils, Karl Franz Achard, son of a French refugee in Prussia after the revocation of the celebrated edict of Nantes, and director of the Academy of Sciences of Berlin, again took up the line of research started by his preceptor, and finally succeeded in extracting sugar from the root on a comparatively large scale. The process he employed was peculiarly his own, and gave results which were at the time of an astonishing character. He announced his results in 1797, publishing his mode of operation, and in the latter part of 1799 presented a sample of his product, with a description of his method, to the Institute of France, stating that the cost of production of muscovado of good quality should not exceed six cents per pound. Achard's statements were as much the subject of doubt and even of severe ridicule by the people of his time as are the statements made by the Department of Agriculture in relation to sugar produced at the present time from sorghum and maize, and were even accepted with reserve by the members of the Institute of France, notwithstanding the high repute he enjoyed among his scientific *confrères*. The interest of the French Institute was so aroused, however, that a commission was appointed by that body to make an examination of the work of Achard and to repeat his experiments. The commission consisted of Cels, Chaptal, Darcet, Fourcroy, Guyton, Parmentier, Tessier, Vauquelin, and Deyeux. In their report they stated that Bermond had made unsuccessful experiments in the introduction of the culture of the sugar-cane in France, and the same was the result with the sugar maple, for though the latter might possibly be grown it could never compete with the sugar-cane. Other plants had been experimented with; the turnip, carrot, parsnip, chestnut, stalks of maize, and many other plants were submitted to experiment, but notwithstanding the assertions of certain enthusiasts it was proven that none of these plants could supplant the cane, and that in spite of the sugar they were presumed to contain the experiments were unsuccessful. Such was the state of things when Achard made the announcement of his experiments and results.

The commission then proceed to state that they had repeated the experiments of Margraff to determine the value of their roots, finding them to contain a little over six per cent. of sugar. They applied the method of Achard for extraction on a larger scale, repeated several times, and succeeded in obtaining only a muscovado of very brown color and disagreeable to the taste. This muscovado, however, was readily purified

by means of alcohol, and in this way a sugar candy was obtained differing in no particular from that given by cane sugar.

The conclusions arrived at were to the effect that if with Achard's process sugar may be extracted from the beet, the quantity was much less than that given by the alcohol process indicated by Margraff.

They then modified the experiments by working on the juice of uncooked beets and obtained 25 per cent. more of muscovado; and as a final result of all their experiments they adopt as the cost of refined sugar about 18 cents per pound, but think this figure may be reduced by improved methods.

The report concludes as follows:

It results from what precedes:

1. That it is certain that the beet which grows in France, and which may be recognized by its white flesh, traversed by red bands or rays, contains sugar as well as the same species grown at Berlin that Achard worked upon.

2. That the sugar may be extracted by various processes, and acquire by aid of repeated purifications all the qualities of cane sugar.

3. That the quantity of sugar which this root contains is so great that attention should be given to its extraction.

4. If, as we are assured by Achard, we may, as it were, render this root richer in sugar at will by caring for its culture, it is desirable that experiments be made upon this subject.

5. That independently of these experiments it would be of value to determine if, among the several varieties, some do not exist more rich in sugar than those pointed out by Achard.

6. That, admitting the results of these experiments, it remains to be demonstrated that the beet may up to a certain point supplant the sugar-cane.

7. That it is true to say that the cost of sugar cannot be determined with rigorous exactness without knowing the results of operations made on a large scale. However, at the present time it may be presumed that this price would not be higher than that of cane sugar in ordinary times.

8. Finally, if Margraff should justly be cited as being the author of the discovery of sugar in the beet, it must also be admitted that Achard is the first to have made fortunate application of this discovery, not only in announcing the favorable quantity that may be extracted, but also in pointing out the processes to which we could resort for success.

Achard's appreciation of the action and conclusions of this commission may be gleaned from the following letter addressed to Citizen von Mons, and dated Berlin, November 16, 1800 (*Ann. de Chem.* 39, 223):

I thank you sincerely for sending me the interesting report of the Institute. I have noted with infinite pleasure that the researches made by the celebrated French chemists confirm my discovery. The differences found in the products as to the quantities and qualities result either from the culture of the beet or the variety chosen for the tests. Notwithstanding the objections of the commission, I am still of the opinion that the best method consists in boiling the roots before expressing the juice, the clarification then taking place within the cells themselves by the coagulation of the albumen, so that we obtain the juice entirely clarified, or better clarified than it is possible to attain from raw beets by the addition of blood or other coagulable substances.

But the report of the French commission had the effect to dampen any enthusiasm that may have been aroused in France by the publication of Achard's announcement, and for the few years that immediately

followed it no interest seems to have been manifested there on the subject.

It was, however, otherwise in Germany. Achard's letter proves that his zeal was in no way abated, and other workers were eagerly following the new line of investigation and experiment now made so attractive by Achard; and Lampadius, professor of chemistry and metallurgy at the School of Mines at Freyburg, took it up, repeated the experiments of his eminent predecessor in the work, improved upon his methods, from the average results of which he estimated the cost of refined sugar would not exceed 18 cents per English pound, about the same limit established by the commission of the Institute. Hermbstaedt also, modifying the method of Achard, succeeded in extracting from 125 pounds of roots of *Beta vulgaris* $5\frac{1}{3}$ pounds of brown sugar and $1\frac{7}{8}$ pounds of sirup, which drained off. The Baron de Koppy, having interest and confidence in the methods and results of Achard, erected in 1805 upon his estate at Krayn, near the town of Strehlen, in Lower Silesia, works capable of the annual extraction of the sugar contained in about 525 tons of roots, besides the manufacture of the rum and vinegar resulting from the utilization of the wastes of manufacture, viz, the pulp and molasses. These works of Koppy were constructed after the designs furnished by Achard, and carried on according to the methods he had determined. Achard also erected a factory on his own estate at Cunern, near Steinau, on the Oder. The results obtained by these two enterprising pioneers in the beet-sugar industry were followed by the establishment of other works at Athaldsleben and near Augsburg, and the interest which had thus been aroused in Germany bid fair to be again communicated to the French. This was hastened by a letter of Achard to the editor of the Moniteur, and published in that journal of October 2, 1808. This so thoroughly explains his position, the character of his work, and the progress he had made since the report upon his former results, that we deem it of value to reproduce it here:

SIR: The manufacture of sugar in Europe being, in all its relations, and principally under existing circumstances, a very important object, I believe that you will not refuse to give publicity, in the Moniteur, to an *exposé* of the results of my researches upon the manufacture of sugar from the beet root, and the advantages which this new kind of European industry assures to all nations for which sugar is an exotic staple.

It was decided by the report given by the celebrated chemists, Cels, Chaptal, Fourcroy, Guyton, Parmentier, Tessier, Vauquelin, and Deyeux, under date of January 25, 1800, to the class of mathematical and physical sciences of the National Institute of France, upon the examination they made of my researches tending to the profitable extraction of sugar from beets—

A. That the beet contains sugar.

B. That the sugar may be extracted by different processes, and acquire by sufficient purification all the properties of cane sugar.

C. That even by following my first methods, which were still very imperfect at the time the celebrated French chemists were occupied with their verification, it was to be presumed that the price of beet-root sugar would not be higher than that of the cane in ordinary times.

D. That all doubts of the existence of sugar in the beet root and the possibility of

extracting it being dissipated, it only remains to be desired that the experiments made on a larger scale may give to my work upon this object the degree of authenticity it merits.

Encouraged by the suffrage of so illustrious savants, I have labored during eight years to perfect the manufacture of sugar from beets by experimental researches made on a large scale, in a factory I have established on an estate called Cunern, which I own near Steinau, in Lower Silesia. My labors have led to the determination of a much more profitable method for extracting the sugar from beet roots, so that by my new processes 25,000 kilograms (55,000 pounds) of these roots furnished 2,309 French pounds (2,098 English pounds) of unclayed muscovado, richer in pure crystalline sugar, in the relation of 662 to 591 than the brown muscovado of Jamaica, or 1,923 French pounds (1,748 English pounds) of a clayed muscovado richer in pure sugar in the relation of 663 to 664 than the white muscovado of Martinique, while by following my first imperfect methods the commission appointed by the Institute of France to repeat my experiments extracted and was able to extract from 25,000 kilograms (52,000 pounds) of roots, the product of 1 arpent of land (about 1 acre), only 782 pounds of muscovado (711 English pounds), containing 448 French pounds (407 English pounds) of pure sugar; that is, about one-third the quantity that may be extracted by aid of my new processes. The cost of production of muscovado from beet root according to my new processes, provided the extraction is carried on in a well-established factory, and the manufacturer secures his roots at the moderate price by growing them himself, as those in the colonies almost exclusively cultivate the cane, is compensated for as much by the leaves of the beets, which serve as food for cattle, as by the rum, other spirits, and vinegar extracted from the wastes of manufacturing the muscovado; that is, the pulp of the root exhausted of the juice which the press can remove, and the molasses.

The same being the case with the cane, it follows that sugar may be extracted with the same pecuniary advantage from the beet in Europe as from the cane in the islands. An arpent yielding, according to the basis determined by the French commission charged with repeating my first experiments, 25,000 kilograms of beets, from which is extracted by my perfected methods 2,309 and 1,923 pounds of muscovado, according to the quality given it, it follows that to produce 10,000,000 pounds of muscovado, it is necessary to set apart during the summer months only between 4,330 and 5,200 arpents of land to the culture of the beet. An area of this extent is too small to cause its use in the production of indigenous sugar to be followed by the restriction of other important cultures, and this is all the more true since it is necessary to set apart for the culture of the beet, as it is practiced in this province, only fields which have been used two years for the culture of spring and winter wheats and remain a third year in fallow without furnishing other products than the pasturage of cattle that are allowed to range upon it, and which is more than compensated for by the leaves of beets. The facts I have established in the preceding article are based—

A. Upon the report which the commission appointed to repeat my first essays in the extraction of sugar from the beet made in 1800 to the class of mathematical and physical sciences of the Institute of Sciences of France.

B. Upon the later official examinations of my manufacture of sugar at Cunern by my newly-perfected methods and the results they have given, made by a commission appointed by the Prussian Government.

C. Upon the results furnished by a beet-root sugar factory established in this province according to my instructions by M. le Baron de Koppy on his place called Krayn, near the town of Strehlen. This establishment is adapted to the annual extraction of the sugar contained in 10,000 Silesian quintals or 577,500 * kilograms of beets, besides the manufacture of the rum and vinegar which is obtained from the wastes of preparing muscovado, viz, the pulp of pressed beets and molasses.

The constant success with which the manufacture of muscovado established at

* 537 tons of 2,200 pounds.

Krayn has worked during three years, and the profit it assures its possessor, confirm the results presented by the official examinations which have been made of the manufacture of muscovado according to my perfected methods, so that it is perfectly proven:

1. That the muscovado furnished by the beet root is of a quality equal to that of the cane.

2. That the quantity of muscovado furnished by beet roots is found so thoroughly proportional to the cost of its extraction and the profits obtained from the waste products of manufacture in employing them for that of rum or other spirits of the better quality, and a very good vinegar, that these advantages under favorable local circumstances wholly, and under all circumstances, in a great part, compensate for the cost of production of muscovado from beets, as is also the case with regard to the muscovado from the cane—the cost of extraction of which is more or less compensated for by the rum extracted from the waste products they leave.

3. That the manufacture of sugar from beet roots may become the object of an important industry for Europe.

a. By the very considerable sums it will save from exportation.

b. By the means it will furnish a large number of persons of the indigent classes to procure subsistence in the manual labor it requires.

c. By the independence in which, with regard to this staple, it places Europe and other parts of the world which are really the principal depositories.

(Signed) ACHARD.

CUNERN, near STEINAU, LOWER SILESIA, 1808.

The following article, from the Moniteur of March 2, 1811, will also be of interest in this connection, as corroborating the statements of Achard:

His excellency, the minister of the interior, in making his report to His Majesty upon the sugar of beet roots, had hoped to be able to assure him that, according to the testimony of M. Deyeux, this sugar would present the double advantage of enriching those who entered into the manufacture and cost a price low enough for consumers.

But if M. Deyeux was unable to give this assurance on account of the fact that the main end of his work was in the interest of French speculators, to effect an improvement upon the processes of the German chemists, we may find it in the success already obtained in the establishment of the Baron de Koppy, success thoroughly recognized in Germany, and of which we have an eye-witness in M. Boudet, chief pharmacist to the army.

It will be remembered that M. Achard, chemist in Berlin, who first conceived the idea of making the extraction of sugar from beet roots an object of speculation and manufacture, announced in the Moniteur of 1802 the advantages of this sugar, which he procured by a process more perfect than that which four years before had not been unreservedly accepted by the Institute of France.

This number of the Moniteur, having reached Breslau, capital of Silesia, and consequently in the neighborhood of the two factories said to exist in the province of Prussia, M. Boudet, being there at the time, considered it of value to verify the facts advanced by Achard, in order in case of need to be able to destroy or increase the impression which the article in the Moniteur may have produced in France. He accordingly betook himself to the house of Baron de Koppy, at Krain,* near the town of Strelzlen.* and visited the manufactory. He caused to be sent to M. Parmentier a memoir, an extract of which was inserted in the *Bulletin de Pharmacie* of the month of February, 1809.

We shall not dwell upon the interesting details into which M. Boudet entered to elucidate for his countrymen the means of establishing similar manufactories in

*In other places these are written Krayn and Strehlen.

Europe. It is sufficient for our purpose here to make known the profit obtained by Baron de Koppy from his own works at the time of the visit of M. Boudet.

He affirms, 1st, that Baron de Koppy is very well satisfied with the quantity of sugar, rum, spirits, and vinegar furnished by his beets, and with the ready and lucrative sale he had for these different staples; 2d, that the culture of beet roots, far from diminishing that of wheat, contributed to procure for him more abundant crops than be obtained before, first, because in employing for beets only the lands formerly left to fallow, his wheat occupied the same area as before he thought of making sugar; and, second, because beets furnish, besides their sugar, a large mass of food for cattle and sheep. He was able, without enlarging his domain, to double the number of his cattle, to obtain more manure, and with the aid of this manure to obtain larger quantities of wheat; 3d. He admitted that he owed to the existing war a large portion of the profits given him by a sugar the people were obliged to use in default of that from canes, but he asserted that should he in times of peace obtain from his factory only the cost of cultivation of the beets and the manipulation of the sugar, he would guard himself from abandoning it so as not to renounce the prosperity it had given him and which it could always preserve on his domain.

The sugar sold by Baron de Koppy was not refined. M. Boudet wished to know for himself if it was susceptible of being. The trial he made having succeeded, he thought this sugar would become that of the richer classes, at least until we have the sugar from grapes M. Proust had led us to hope for, the sirup of grapes having already replaced for the poor that of the cane.

The establishment of beet-sugar factories may therefore be undertaken with confidence throughout the empire; but we must observe, according to the memoir of M. Boudet, it is especially to the large proprietors that it will be profitable, and that they should content themselves with making raw sugar to be sent like that of the islands to the refineries, one of which is able to purify and convert into loaves the products of twenty factories.

As Baron de Koppy admits in his statements to M. Boudet, the events which were brought about by the political conditions of the time did much to favor the success of the enterprise, for shortly after his works were started—in fact, in the years immediately following—Napoleon I issued his famous decrees of Berlin and Milan, establishing the famous continental blockade, and excluding from the markets and consumption all material whatsoever of English production or manufacture, and particularly the products of England's colonies. This, of course, made sugars scarce and dear, and enhanced the profits of the manufacture that Achard and Koppy had so opportunely developed.

The same conditions stimulated the search for products indigenous to France that might be substituted for those colonial staples which had become articles of daily consumption, and the deprivation of which was most keenly felt, and sugar seemed to have claimed instant attention. But the source developed by Achard seems to have almost completely vanished from the thoughts of both scientists and practical manufacturers. The destruction of external commerce, of course, resulted in the downfall of the wine trade, and all eyes and all minds naturally turn to the utilization of the enormous crops of grapes France annually produced, and everybody seemed to look to the sugar this fruit contained, both as a substitute for the wanting colonial staple, and as the rescue from the ruin which appeared imminent to the proprietors of

the vineyards, especially in the south. Parmentier was, among the scientists and members of the Institute, the leader of this movement and the promoter of this apparent germ of a new industry and internal source of national wealth, and he published a work entitled, *Traité sur l'art de frabriquer les sirops et conserves de raisin.*" The methods he indicated in this work were mainly followed in the experiments of 1808 and 1809, but were considerably improved upon by Proust and Fouques. They served, however, in the various southern departments of the empire, for the production of considerable quantities of sirup from the vintages of 1808 and 1809, samples of which were presented to the minister of the interior, who at once called the attention of the Emperor to the results represented in the samples in the following report, which will serve to show not only the condition of the enterprise at the close of 1809 and the beginning of 1810, but also what had been done previous to that time and the appreciation with which he regarded it; and the decree of Napoleon issued in consequence of this report will show the interest he had in this possible source of a substitute for the colonial staple. The report appeared in the Moniteur of June 23, 1810. The minister, Montalivet, says:

SIRE: I have reported to your Majesty the successes obtained by M. Parmentier, who has given very useful attention to perfecting grape sirup and making it suitable to replace cane sugar in many medical and domestic preparations. Your Majesty, who ordered it to be used in the palace, seemed satisfied with it. I desire to-day to fix your attention upon more important results. M. Proust, an able chemist, has extracted from grape sirup a concrete sugar. M. Fouques has found a means of bleaching it and giving it not only the brilliancy but also the consistency and color of cane sugar. I have called together a commission, composed of Messrs. Berthollet and Chaptal, Senators, and members of the Institute, Parmentier, Vauquelin, and Proust. The sugar of M. Fouques was submitted to them for examination. The commission decided that this substance was worthy of the highest degree of attention, and after having made some tests upon the substance itself, without any preparation, thought it especially essential to determine what would be its effects in different mixtures and different proportions. The commission then adjourned, and came together again at the ministry on the 12th of this month.

The commission found that conserves containing the triple and quadruple of grape sugar were too sweet. Those containing the double were less sweet than those containing a single proportion of cane sugar. That the grape sugar equivalent of cane was a little over 2¼ to 1.

MONTALIVET.

In consequence of this report of the minister of the interior, his Majesty issued, under date of June 18, 1810, the following decree:

ARTICLE 1. There is accorded the sum of 100,000 francs ($20,000) to M. Proust,* and one of 40,000 francs ($8,000) to Sieur Fouques, in the form of gratuity and by way of encouragement for the discovery they have made of grape sugar.

ART. 2. They shall be obliged to use these two sums to establish grape-sugar factories in that portion of our southern departments designated by our minister of the interior.

* By decree of June 21, 1810, Napoleon appointed M. Proust, chemist, member of the Legion of Honor.

ART. 3. They shall be obliged to give up the secret of their processes, which shall be rendered public, and be sent to all the prefects of our grape-growing departments.

ART. 4. From January 1, 1811, at the latest, the sugar of grapes shall replace in all public establishments the sugar of canes.

ART. 5. Our minister of the interior shall recommend to the prefects to propagate and encourage the establisment of factories for either grape sirup or concrete grape sugar, so that in the coming year the inestimable advantages of this precious discovery shall make itself felt for the good of all our people and the interests of our commerce.

The same commission to whom was submitted for examination the samples of sirup and sugar produced by Messrs. Proust and Fouques were directed by the minister of the interior to prepare detailed instructions upon the methods to be followed for the successful and profitable extraction of sirup and concrete sugar from grapes, and the result of the work they at once entered upon, a copy of which may be found in the Moniteur of August 25, 1810, was printed and distributed throughout the grape-growing departments of France, in company with the following circular letter to the prefects of those departments, under date of August 18, 1810:

MONSIEUR LE PRÉFÊT: His Majesty the Emperor desires to give an impulse to the manufacture of sugar and sirup from grapes, and he has ordered that there be prepared to this effect simple instructions indicating the best processes to follow. He wishes that the instructions prepared by the most celebrated savants, and generally distributed, may lead proprietors to make sirup and sugar for their own uses, and place manufacturers in the way of making it in the surest and most economical manner, and completely supplying the markets with products from the next vintage.

I send you several copies of these instructions. Be so good as to distribute them to your officers who will make the best use of them, and cause them to be printed in the journal of your department.

You must not content yourself with causing the description of the process of manufacture of sugar and sirup from grapes to be distributed to even the smallest communes; you shall stimulate the zeal of your officers; you shall promise and accord prizes to those who shall have made the most of sugar and sirup of the best quality. I will supply, upon your requisition, the funds you may dispose of.

I also invite you to immediately confer with directors of hospitals and other charitable establishments of your department, that they in turn may confer with farmers, proprietors, and pharmacists who may desire to make sirups and sugars, and arrange with these persons such markets as will assure the sale of the products of this year. You shall preside over these arrangements, and take care that, without injuring the interests of the poor, there may be all-sufficient encouragement for manufacturers.

You shall address to me a table of the quantities of sugars and ordinary sirups annually consumed in each hospital, and of the presumed consumption of the coming year in sirups and sugars of grapes, with indications of the markets which have been recorded.

The subprefects and mayors will, I hope, second you in all your efforts. You shall make known to me those functionaries and special persons who shall be most distinguished in this sphere of usefulness which is open to them. I shall report their efforts and their success, as well as your own, to the Emperor.

Let manufacturing establishments multiply everywhere. Let it be considered, M. le Préfêt, that this is a sort of war we are making against the enemies of the Continent, and which his Majesty considers, more than any other sovereign, worthy of recompense to those who make themselves prominent in the ranks.

Count MONTALIVET,
Minister of the Interior.

Immediately after this the Emperor issued the following decree, dated August 22, 1810:

Considering that the economical manufacture of sugar from grapes essentially influences the prosperity of agriculture and commerce, and desiring to give to this important branch of the industry a particular mark of our special protection, we have decreed and do decree as follows:

ARTICLE 1. On June 1, 1811, the sum of 200,000 francs ($40,000) shall be distributed among twelve establishments which shall have made the largest quantity of sugar from grapes.

ART. 2. The distribution shall be made among the twelve establishments proportionally to the quantity of sugar that each one shall have made.

ART. 3. To secure the right of competition it shall be necessary to have made at least 10,000 kilograms (22,000 pounds) of sugar.

ART. 4. The quantities of sugar made shall be verified by a commissioner appointed for that purpose by the prefect of the department and certified to by the mayor of the place.

ART. 5. The prefect shall address these evidences to our minister of the interior before May 1, 1811. He shall also send at the same time a sample of the sugar made.

ART. 6. Our minister of the interior shall make to us a report to this effect. He shall make known to us at the same time the manufacturers who have perfected the processes of manufacture and shall propose to us the recompenses and encouragements they shall have merited.

But while these encouragements were being given to the enterprise of producing sirup and sugar from grapes in the south to replace the colonial staple in the home consumption of France, the results of Achard's later work, as described in his letter to the editor of the Moniteur in 1808, had awakened anew the interest in the beet root as a source of sugar in the north, and M. Deyeux, reporter of the first committee of the Institute, which conducted the experiments of 1800, in compliance with a request made through the Institute by the minister of the interior, again undertook to repeat in 1809 and 1810 the experiments of the former committee, and the later work of Achard, with such modifications as he deemed advisable and practicable. In this work he was associated with Mr. Barruel, chief of the chemical department of the School of Medicine of Paris, and their labors were rewarded by the production of a certain quantity of muscovado, which they refined and thus secured "two loaves of sugar, perfectly crystallized, of great whiteness, brilliant and sonorous, in a word enjoying all the properties of the finest cane sugar," one of which was presented by the minister of the interior to the Emperor, who is said to have "received it with that benevolence which he accords to every useful object." But these experiments, while they showed the practicability of extracting sugar from the beet root by the means proposed, were still not of a character to show the net cost of producing the sugar, because the experimenters viewed the work only in a chemical sense. Messrs. Barruel and Isnard then undertook to determine this part of the question, and repeated these experiments just mentioned, keeping strict accounts of the cost of each stage of the processes applied and the quantities of the products obtained. It was found that by their processes they were able to extract 1.5 per cent. of muscovado, which

cost 30 cents per pound. The refined sugar produced from this lower grade cost 40 cents per pound. It appears, however, that the beets treated, which were grown upon the highly manured lands of the plain of Vertus where their works were located, were very unfavorable to the results of the experiments. It also appears that these figures represent the actual cost to the experimenters in the extraction of the sugar, taking no account of the by products and assigning the maximum price for the beets worked; but the further estimates of cost made up by Messrs. Barruel and Isnard, based upon their own experiments and working by their own processes, supposing the value of the beets to be the actual cost of producing them and the amount of roots handled to be the yield of about 400 acres of land, about 6,000 tons, show that the cost of production should not exceed 8 cents per pound for good muscavado, or 12.9 cents per pound of refined sugar.

The actual condition of the sugar enterprise in France at the close of 1810 may be gleaned from the following report to the Emperor by Montalivet, under date of January 10, 1811.

The production of sirup and sugar from grapes ordered by your Majesty is pursued with activity; and even though the season has not been very favorable to the vine, I am in daily receipt of proofs of the zeal with which a large number of proprietors are animated in the different departments, but those of the south and the center are the only ones who may engage in this manufacture, and on this account I would respectfully submit to your Majesty the results which lead us to hope that even the departments of the north may find upon their territory a sugar of very good quality. We know that for some years back beet-root sugar has been manufactured at Berlin and Breslau. Messrs. Achard and Koppy addressed to my predecessor very beautiful specimens of this sugar, but up to the present but slight results have been obtained. M. Deyeux, first pharmacist to your Majesty and member of the Institute has just reundertaken this work and has obtained very remarkable success in the results which he has addressed to me, and which I submit to your Majesty. He has also addressed to me an interesting memoir in which he has reported to the Institute the processes he employed to arrive at his results. He believes these processes to be more simple and better than those adopted by Messrs. Achard & Koppy. But M. Deyeux, obliged to devote himself to trials and experiments to find a good method, is unable as yet to establish the price at which this sugar can be produced. Everything shows, however, that this price will be sufficiently low to prove a large source of profit to extended manufacture. Already, in the department of the Doubs, a rich proprietor, Mons. Secci, has established a manufacture of this kind and has sown 80 acres in beets, which have yielded him 500,000 kilograms (500 tons) of roots, from which 25 to 30 milliers (27,500 to 33,000 pounds) of refined sugar may be expected. The prefect of Mont Tonnère has also informed me that Mons. Molar, a proprietor in his department has sown 80 hectares (197.6 acres) of ground in beets which he proposed to convert into sugar, and for which operation he asks to be admitted to the prizes which your Majesty has deigned to promise to manufacturers of sirup and sugar from grapes. In the Department of Roer, the manufacture of sugar from beet-roots is carried on by the brothers Herbem at Urduiger. The prefect of the Rhine and Moselle has transmitted to me samples of a very fine cassonade from beet roots, manufactured by Mons. Anthonin, who asks for encouragement to enable him to enter upon this manufacture on a large scale. Finally, for Holland, the prince governor-general has sent me a sample of beet-root sugar made by M. Linden at Hemmer, in whose labors he appears to have confidence; and the prefect of the Bouches-du-Rhone has shown me samples of beet-root, sugar made by M. Vanrroggen, one of his officers.

I shall, at a later date, report to your Majesty the results which these different attempts promise. At this time, I confine myself to presenting the sugar made by M. Deyeux. It in no way differs from the refined sugar of the colonies. This test shows what may be expected from this work as regards the quality of the material. I shall now study carefully the means of determining to what extent this manufacture may become economical and the measures to be taken to render it general in the Departments of the north.

MONTALIVET,
Minister of the Interior.

It is to be remarked further that prizes were also offered by the *Société d'Encouragement pour l'Industrie Nationale* for the production of sugar from grapes or beets, the annual prize being 2,400 francs ($480) for the best essay and sample, 1,000 francs ($200) for second best, and, on February 20, 1811, it received, through its founder and then president, Count Chaptal, a memoir upon the methods for the extraction of sugar from beets, by M. Drappiez, a pharmacist at Lille, together with a loaf of the sugar, of which he had been able to obtain 50 quintals by the method he described. The committee on chemical arts of the society compared the sample of sugar submitted by M. Drappiez with a sample of refined cane sugar they were then able to obtain at a cost of 95 cents per English pound, and failed to detect the "*slightest difference*" between them. M. Drappiez obtained by his method a yield of 1.3 per cent., the cost of which he estimated at 80 cents per pound.

Shortly after this there appeared in the Moniteur of March 23, 1811, a statement to the effect—

That there had been presented to his Majesty several quintals of refined crystallized beet-root sugar, having all the qualities of that of the cane; loaves of both kinds have been mixed together, and it was impossible to distinguish between them. It follows from the report of a commission charged with the examination of the different means proposed to replace by indigenous processes the foreign productions so costly to France, that 70,000 acres cultivated in beet roots would furnish the 30,000,000 of pounds necessary to our consumption.

And two days later Napoleon issued the first decree, in which he provided for direct encouragement of the beet-sugar industry, and which was as follows:

PALACE OF THE TUILLERIES, *March* 25, 1811.

NAPOLEON, *Emperor of the French, &c.:*

Upon a report of a commission appointed to examine the means proposed to naturalize, upon the continent of our empire, sugar, indigo, cotton, and divers other productions of the two Indies:

Upon presentation made to us of a considerable quantity of beet-root sugar, refined, crystallized, and possessing all the qualities and properties of cane sugar:

Upon the presentation made to us at the council of commerce of a great quantity of indigo, extracted from the plant woad, which our departments of the south produce in abundance, and which indigo has all the properties of the indigo of the two Indies:

Having reason to expect that by means of these two precious discoveries our empire will shortly be relieved from an exportation of 100,000,000 francs ($20,000,000) hitherto necessary for supplying the consumption of sugar and indigo:

We have decreed and do decree as follows:

ARTICLE 1. Plantations of beet root proper for the manufacture of sugar shall be formed in our empire to the extent of 32,000 hectares (79,040 acres).

ART. 2. Our minister of the interior shall distribute 32,000 hectares among the departments of our empire, taking into consideration those departments where the culture of tobacco may be established, and those which from the nature of the soil may be more favorable to the culture of the beet root.

ART. 3. Our prefects shall take measures that the number of hectares allotted to their respective departments shall be in full cultivation this year, or next year at the latest.

ART. 4. A certain number of hectares shall be laid out in our empire in plantations of woad proper to the manufacture of indigo in the proportion necessary for our manufacture.

ART. 5. Our minister of the interior shall distribute the said number among the departments of our empire, taking into particular consideration the departments beyond the Alps and those of the south, where this branch of industry formerly made great progress.

ART. 6. Our prefects shall take measures that the number of hectares allotted to their departments shall be in full cultivation next year at the latest.

ART. 7. The commission shall, before the 4th of May, fix upon the most convenient places for the establishment of six experimental schools for giving instruction in the manufacture of beet-root sugar conformably to the processes of chemists.

ART. 8. The commission shall also, before the same date, fix upon the places most convenient for the establishment of four experimental schools for giving instruction upon the extraction of indigo from the lees of woad, according to the processes approved by the commission.

ART. 9. Our minister of the interior shall make known to the prefects in what places these schools shall be formed, and to which pupils destined to this manufacture should be sent. Proprietors and farmers who may wish to attend a course of lectures in the said experimental schools shall be admitted thereto.

ART. 10. Messrs. Barruel and Isnard, who have brought to perfection the processes for extracting sugar from the beet root, shall be specially charged with the direction of two of the six experimental schools.

ART. 11. Our minister of the interior shall, in consequence, cause to be paid the sum necessary for the formation of the said establishments, which sum shall be charged to the fund of 1,000,000 francs ($200,000) in the budget of 1811 at the disposal of the said minister for the encouragement of beet root-sugar and woad indigo.

ART. 12. From the 1st of January, 1813, and upon a report to be made to our minister of the interior, the sugar and indigo of the two Indies shall be prohibited, and considered as merchandise of English manufacture or proceeding from English commerce.

ART. 13. Our minister of the interior is charged with the execution of the present decree.

Early in the following April, 1811, Decostils, reporter of the committee on chemical arts of the *Société d'Encouragement pour l'Industrie Nationale*, reported upon a memoir and results presented by M. Derosne. He was the first to suggest the use of quicklime in the purification of the juice. His method was based upon three principal points: (1) the use of caustic lime; (2) the use of alum; and (3) the use of alcohol. The lime he adds to the fresh juice, of which he succeeded in expressing 63 per cent. the weight of the root. The proportion added was 0.24 gram per liter of juice. After the addition of lime in a thick milk the juice was rapidly brought to boiling and the scums removed as they formed. The juice was then separated

from the sediment, which settled and concentrated. It was then purified with alum and blood, and further treated in the usual way. The proportion of sugar extracted by this method is stated to have been 4½ per cent., and was the highest result that had yet been attained. The beets from which this high yield was obtained were of the white Swedish variety, while the beets of the plain of Aubervillier did not yield as much by 2½ per cent.

After the announcement of this method of Derosne, it appears that little was published on the subject of the new industry that was now beginning to assume important dimensions until the beginning of the following year, when Montalivet reported to his Majesty that 6,785 hectares (16,758 acres) had been sown in beets in different departments of the empire, producing 98,813 tons of roots.

The number of factories established was 39 or 40, and the minister estimated that if the whole product were worked up the result would be 1,500,000 kilograms (3,300,000 pounds) of sugar; but the plantations were in many cases too far removed from the factories to make it possible to transport the roots with profit. He also gave a table showing the number of hectares sown in beets in each department, the quantity of roots harvested, and the reasons which prevented more extensive planting in each. The latter seemed to be, principally, lack of sufficient seed and lateness of the season.

About the same time a report was made to the Emperor by Count Chaptal showing the cost, by the methods then known and in use, of the culture of the beet and the manufacture of sugar. The first he estimates at 176 francs per metrical arpent (about $35 dollars per acre), the yield of which varies from 12,000 to 45,000 to 50,000 pounds. The second cost he estimated at 15 cents per pound, supposing all the molasses to be sold; but if no molasses be sold then he estimates that the cost would reach 30 cents per pound. For the cost of refined sugar he makes two estimates: the first supposing 15 cents per pound as the value of the raw sugar, and in the second he values it at 30 cents. According to the first supposition the cost would be 32 cents per pound, and 45½ cents according the second supposition.

In concluding his report, Chaptal says an intimate knowledge of chemistry is necessary for successful work; and he recommends, as a means for assuring the prompt prosperity of this enterprise, that there be established at one of the factories already established a normal school, and that there be brought together there 30 or 40 young men already versed in chemical knowledge, and 40 others taken from among the children of refiners of Orleans, Antwerp, Ghent, Marseilles, Nantes, Amsterdam, &c., and from among the chiefs of refineries in the larger towns; and the establishment at which, it seemed to him, such instruction as he referred to could be given was that of M. Barruel in the plain of Vertus.

On the 12th of January, 1812, M. Barruel published a note upon the

manufacture of beet-root sugar, and describes the method he had finally devised for extracting the sugar, and in this description we find the first mention of the use of carbonic acid for separating the excess of lime remaining after purification of the juice. He proceeds as follows: The juice is heated to 65° R.; milk of lime is then added (295 grams quicklime per 100 kilograms of juice, or 295 parts in 100;000); the whole stirred thoroughly and heated to 80° R. The coloring matter, &c., forms in soluble compounds and makes a flocculent precipitate. A solid scum forms on the top. The latter is skimmed off and the liquid decanted. The clear juice is then freed from lime, and for this purpose an acid which forms an insoluble compound with the lime is the best, sulphuric or carbonic acids preferred. Alum may be used according to Derosne's method, but this only acts by the sulphuric acid it contains, and while for equal weights sulphuric acid costs more than alum, it will neutralize more of lime.

M. Barruel considers, however, that carbonic acid is the most economical of all, and for his purpose he prepares it by passing air through burning coals.

In the conclusion of his note he says: "This process, which is very simple and not costly, always succeeds. I guarantee its exactness and success."

Maumené states that about this time Napoleon visited a factory at Passy, where Benjamin Delessert had succeeded in producing white sugar from beets, and after having given him the cross of the Legion of Honor (the same which ornamented his own breast) as a recompense for this splendid initiative, the Emperor caused to be inserted in the *Moniteur* of the following day the grand evolution that had been consummated in French commerce. But of this circumstance we are unable to find any record in the *Moniteur* or the *Journal de l'Empire* of that period.

On January 15, 1812, Napoleon issued the following decree, in all probability a result of the report made by Count Chaptal:

SECTION I.—SCHOOL FOR MANUFACTURE OF BEET-ROOT SUGAR.

ARTICLE 1. The factory of Messrs. Barruel and Chappelet, plain of Vertus, and those established at Wachenheim, department of Mont-Tonnère, at Douai, Strasbourg, and at Castelnaudary, are established as special schools for the manufacture of beet-root sugar.

ART. 2. One hundred students shall be attached to these schools, viz: 40 at that of Messrs. Barruel and Chappelet, and 15 at each of those at Wachenheim, Douai, Strasbourg, and Castelnaudary; total, 100.

ART. 3. These students shall be selected from among students in medicine, pharmacy, and chemistry.

SECTION II.—CULTURE OF BEETS.

ART. 4. Our minister of the interior shall take measures to cause to be sown throughout our empire 100,000 metrical arpents of beets. The conditions of the distribution of the culture shall be printed and sent to the prefects previous to February 15.

SECTION III.—MANUFACTURE.

ART. 5. There shall be accorded throughout our entire empire 500 licenses for the manufacture of beet-root sugar.

ART. 6. These licenses shall be accorded of preference—

To all proprietors of factories or refineries;

To all who have manufactured sugar during 1811;

To all who have made preparations and expenditures for the establishment of factories for work in 1812.

ART. 7. Of these licenses there shall be accorded of right, one to each department.

ART. 8. Prefects shall write to all proprietors of refineries, in order that they may make their submissions for the establishment of the said factories at the close of 1812. In default on the part of proprietors of refineries to have made their submissions prior to March 15, or at the latest April 15, they shall be considered as having renounced the preference accorded them.

ART. 9. Licenses shall include an obligation on the part of those who shall obtain them to establish a factory capable of producing at least 10,000 kilograms (22,000 pounds) of raw sugar in 1812–'13.

ART. 10. Each individual who, having received a license, shall have actually manufactured nearly 10,000 kilograms of raw sugar resulting from the crop of 1812 to 1813 shall have the privilege and assurance, by way of encouragement, of being subject to no tax, or *octroi*, upon the product of his manufacture for the space of four years.

ART. 11. Each individual who shall perfect the manufacture of sugar in such a manner as to obtain a larger quantity from the beet; or who shall invent a more simple and economical method of manufacture, shall obtain a license for a longer time, with the assurance that no duty nor *octroi* shall be placed upon the product of his manufacture during the continuance of his license.

SECTION IV.—CREATION OF FOUR IMPERIAL FACTORIES.

ART. 12. Four imperial beet-sugar factories shall be established in 1812 under the care of our minister of the interior.

ART. 13. These factories shall be so arranged as to produce with the crop of 1812 to 1813, 2,000,000 kilograms of raw sugar.

We find one of the practical results of this generous decree in the announcement made by Charpentier *frères* of Valenciennes, Departement du Nord (*Journal de l'Empire* of December 2, 1812), that they had for sale 12,000 kilograms (26,400 pounds) of beet-root sugar manufactured from the crop of that year, and during the first two months of work. The large quantity of beets they still had in store assured them, it was stated, for the end of April, 1813, a product of 60,000 kilograms (132,000 pounds), which they offered to sell as it should be made.

But these results are more fully described by the minister of the interior, in his report upon the situation of the empire in the beginning of 1813, in which under the head of new industries he says:

To replace in our consumption the sugar, indigo, and cochineal of the colonies; to find in the south of Europe and at home the cottons and soda to supply our manufactures seemed impossible. It was ardently wished for, and the impossibility disappeared before our efforts.

During this year the manufacture of sugar which is extracted from the beet root will give us 7,700,000 pounds of this staple. It is prepared in 334 factories, all of which are in actual activity.

After numerous trials, processes are finally employed by which beet-root sugar will not cost more than 15 cents per pound to the manufacturer. Mr. Bonmatin, in-

ventor of this new method, profited by the useful labors of his predecessors, and the government, in order to hasten the fortunate results of his discovery, charged him to proceed to propagate it in those sections in which the principal manufactories are established.

Since the establishment of the high price of sugar, consumption has greatly decreased, and the seven millions of pounds manufactured at this time may be considered equal to at least one-half our actual needs. This diminution is not the result of any absolute privation that may have occurred, but from the equivalents by which sugar has come to be replaced.

Several millions of pounds of sirup from grapes, and honey, the latter better purified and more abundant, have been substituted for sugar in a great portion of the domestic uses with so much of ease that the most delicate taste could scarcely perceive the change.

When the difficulty of procuring sugar and its cost shall be less; when the first profits, at present so great, if they be considered only as interest upon capital, shall have covered the cost of establishing, the quantity that will be consumed will again increase, the equilibrium will be renewed, and supposing that one-fifth the consumption to remain definitely replaced by sirup of grapes and honey, France will consume 40,000,000 pounds of beet-root sugar, the value of which will be 30,000,000 francs, and we may count upon these results for 1814. Our refineries now yield a product of 10,000,000 pounds, which will increase to at least 20,000,000 pounds.

In the six years beginning with 1802, we received from abroad an annual average of 52,000,000 pounds of sugar. During the four years beginning with 1809, the average annual importation has been but 10,000,000 to 11,000,000 pounds. It is especially since that time that nothing has been neglected to naturalize this staple at home, and the conquest is finally assured.

But while all this interest and busy enterprise was being manifested in France, great progress was also being made in Germany. And the generous and worthy action of Napoleon in extending substantial encouragement to the development of the growing industry which produced such happy results had even been anticipated by the German government, which came to the aid of Achard, who had for nearly fifteen years devoted all his time and limited means to the development and establishment of the industry, in the ultimate success of which, in spite of all the reverses to which he had been subject, he had never lost faith. His influence and example had led to the establishment of the works of Baron de Koppy at Krayn, and his watchful care over it had assured its financial success. And this besides those already mentioned was followed by the establishment of works in other sections, notably by Baron von Lorentz, Counselor Mengen, and more especially the Messrs. Mayer of Breslau, who, we are told by Isnard, director of the special school of chemistry for beet-sugar manufacture at Strasbourg, had for ten years sown about 750 acres in beets. In view of the progress attained and the interest manifested, the governmental authorities accorded to Achard, during the course of 1810 and 1812, the encouragement and aid indicated in the following notice sent by Achard to the Moniteur, and published in that journal, June 23, 1812, showing also the progress this pioneer in the industry had made. He says:

The public has, during the past year, been informed, as much by the decrees of the regency of Silesia as by the several writings I have published, that his Majesty, the

King of Prussia, has ordered me to establish on my two estates of Upper and Lower Cunern, near Wohlen, in Lower Silesia, a practical school for instruction as complete as possible, to make known to our people as well as to foreigners the processes employed in the extraction of sugar from beet roots.

He further states that he had three distinct methods for extraction, using neither lime, carbonate of lime, milk, sulphuric acid, nor alum, except for beets of poor quality, or toward spring when vegetation has commenced. By the new method he succeeded in getting concrete sugar in twenty-four hours. The three methods of separating the sugar from sirups of beet juices are: 1, by regular crystallization; 2, by granulation; 3, by immediate conversion into bastard sugar. By the first method 1 quintal of juice gives 5 Silesian pounds of sugar. By the second 6 pounds are obtained, and by the third method, which is preferable to all others, the sugar may be extracted in twenty four hours, yielding 5 pounds of raw sugar.

This notice of Achard is followed by one from the Royal Regency of Silesia, upon the establishments of Achard, stating that—

His Majesty the King of Prussia, in giving to M. Achard a considerable sum of money, prescribed that he should establish and maintain upon his estate, and at his own cost, a factory for instruction in the manufacture of sugar from beets.

In the month of December of last year (1811), Achard having announced to the Royal Regency that he had established two factories—one factory on a small scale and such as could be united with farm management, the other to manufacture sugar on a large scale; that the building for lodging students was finished and ready to receive them; that the course of instruction would commence in January; and that he would be flattered to see an official examination of his work—we consequently appointed for this purpose two intelligent persons, who found that the buildings intended for the manufacture were actually completed, and provided with the apparatus and machinery necessary. It also appears from this report that since January 12 (1812), the manufacture has been in full activity, and that besides the students there were employed in the factory a foreman, nine male, and four female laborers. During the course of instruction 20 quintals are worked upon daily. Five pounds of raw sugar per quintal [110 pounds] are extracted, and, according to exact calculations made at the factory, it follows that 100 quintals of beets give a net profit of something more than 111 thalers current money.

This model factory and school of Achard attracted students from nearly all the nations of the continent, and it is probable that it was the students he had from Russia who carried back to their country the germs of this industry, which has now become so powerful there, and which in that country received its establishing impulse through the aid and encouragement extended by the imperial authority; for it is related that General Blankenagel, who founded a factory in the government of Toula, at the village of Akabef, had received from the Czar of Russia a gift of 50,000 roubles ($38,895), and that a ukase or edict of the Emperor gave the assurance that all lands of those establishing sugar factories should be free from tax.

Such, then, was the progress attained in this new and valuable industry, and its condition in the beginning of 1814, during which memorable year what had bid fair to be a great source of national wealth and

prosperity to all the continental nations received almost its death-blow. The beginning of the war with Russia interfered with its progress in that country. The destructive passage of foreign and contending armies destroyed completely not only this, but other and more flourishing industries in Germany, and the final conflict on French territory and the downfall of Napoleon, who has been described as the second father of the industry, resulted in its almost complete extinction in France, and the withdrawal on the part of the immediate successor of the great Emperor of the encouragement he had accorded was nearly as disastrous as had been the malicious depredations which were perpetrated by the enemy's troops, and it required the patient labor of more than another decade to accomplish what Napoleon had been able to establish in about one-third that time.

But it must not be supposed that this new enterprise, which had assumed such formidable proportions, was during its development favored with a constant belief of the entire people of all nations in its value and its efficacy to supply a substitute for the staple of the tropical climes, which had formed the basis of much of the maritime commerce of the time. If Achard received ridicule at home and was looked upon by many of his countrymen as an insane enthusiast, but which prejudice by presentation of substantial evidences he was able to dissipate, the criticisms heaped upon Napoleon were of the bitterest character abroad, and the mutterings which could not under imperial rules enjoy unrestrained expression were not unknown to him, nor did they in any way affect the firmness of his resolution or his charity toward his critics at home, as is shown in the following address he made to the chamber of commerce March 11, 1811, in which he says:

The Berlin and Milan decrees are the fundamental laws of my empire as regards neutral commerce. I consider the flag an extension of territory, and the nation which suffers it to be violated shall not be considered neutral.

The fate of American commerce shall soon be decided. I will favor it if the United States will conform to these decrees; on the contrary, their ships will be excluded from my empire.

Commercial relations with England must cease. I proclaim it to you, gentlemen, distinctly. Merchants who have transactions there to settle or funds to withdraw should do it as quickly as possible. I gave this advice some time ago to the merchants of Antwerp, and they have profited by it.

I wish for peace, but not a patched-up one. I wish for it sincerely, and for such an one as will afford me sufficient guarantees, for I have not lost sight of Amiens or St. Domingo, or the losses which commerce sustained from the last declaration of war.

* * * * * * *

I have a knowledge of what is passing in the counting houses of merchants. I know they denounce in high terms my measures and say I am badly advised. I will not blame them for their impressions, because, not having a view of the whole ground, they have not an opportunity to calculate and judge as I do. Nevertheless, those who have lately arrived from England will inform you of the injurious consequences produced in that country from an interruption of their commerce with the continent, and may say it is possible I am right and that my designs may be accomplished.

* * * * * * *

I am informed that from late experiments France will be enabled to do without the

sugars and indigoes of the two Indies. Chemistry has made such progress in this country, that it will possibly produce as great a change in our commercial relations as that produced by the discovery of the compass. I do not say, gentlemen, that I do not wish for maritime commerce or colonies, but it is proper to abandon them for the present, and until England shall return to just and reasonable principles, or until I can dictate to her the terms of peace.

* * * * * * *

I know the English have better admirals, and that is a great advantage, but by often fighting them we shall learn to conquer.

* * * * * * *

The vent of colonial produce upon the Continent being once firmly shut, the English will be obliged to throw into the Thames the sugars and indigoes for which they have exchanged objects of their industry, and which have afforded them such resources.

It is stated that about this time a caricature was exhibited in Paris, in which the Emperor and the King of Rome were the most prominent characters. The Emperor was represented as sitting in the nursery with a cup of coffee before him, into which he was squeezing a beet root. Near him was seated the King of Rome voraciously sucking the beet-root, while the nurse, standing near and steadfastly observing, is made to say to the youthful monarch, "*Suck*, dear, *suck;* your father *says* it is sugar!"

But as the doubt and ridicule here indicated gave way to a large extent in France before the development of the industry, that expressed in the English journals also gave place to an undercurrent of anxious inquiry as to the possible fate of the English colonial commerce, and the probable extent of the development of the new industries that were being so ardently fostered by Napoleon; and it is related by the Prince Louis Napoleon that the English Government even made anonymous offers to Achard, first of the sum of $40,000, and later on of $100,000, if he would publish a work declaring that he had been carried away by his enthusiasm in his former publications, and that the results he then made public had by no means been confirmed by his later work. Failing in effecting in this way the result desired, it is said the government induced Sir Humphrey Davy to write a brochure, in which he declared that, while sugar could be produced from the beet, the product was too bitter for consumption.

But the impotency of these attacks upon the new industry is fully illustrated in its subsequent history. Napoleon, in his wisdom, continued his substantial encouragement of this and other agricultural and manufacturing industries in France by the appropriation of several millions of francs in their support at a time when the total revenue of his empire did not exceed 999,000,000 of francs (less than $200,000,000) and he was maintaining large armies in Spain and Portugal, and a very formidable navy on the high seas.

But if the industry Napoleon had fostered and established fell with his downfall, its value had been demonstrated, and was even admitted in the first report of the Abbé de Montesquieu, minister of the interior under Louis XVIII, a report filled with the bitterest criticisms of the

policy of the imperial government, accusing it of tyranny and imposition upon the rights of the people as concerns the manufacturing interests. In the course of this report the minister remarked that—

> Mechanics and chemistry, enriched by a crowd of discoveries and ably applied to the arts, had caused rapid progress. The continental system, by forcing manufacturers to seek upon our own territory hitherto unknown resources, brought about some useful results.

The condition in which the wars left France and her industries at the beginning of 1815 necessitated the production of the revenue for the support of the government from external sources, for her fields and factories could not then bear a tax sufficient for the purpose. The customs duty this required maintained the prices of colonial staples at rates even higher than those which prevailed during the preceding reign, and operated as a substitute for the encouragement before given by the government. It was on this account that the one factory, that of M. Crespel, at Arras, in the department of the North, which had survived the general wreck, was able in a year or two to yield to its enterprising owner and director a fair income with which to retrieve his broken fortune, and to again extend the industry in which it was shown he had such a deep interest. With the profits attained by one factory he established another until he finally became the proprietor of ten of the finest works of his time. His intelligence, industry, and enterprise gave an impetus to the culture and manufacture of the crop, and his example was soon followed by others in different parts of the country, and factories were established and worked with varying success. In 1823, Dubrunfaut published, in his work on the manufacture, information concerning the condition of the industry at that time, that he had been able to obtain on a tour among the principal factories of the day. From this work we gather the facts and figures tabulated below concerning the cost of culture of the beet and of the manufacture of sugar by some of the most progressive and successful manufacturers he had occasion to visit.

Name of grower.	Yield per acre in tons of 2,200 pounds.	Cost per ton of roots.
Mathieu de Dombasle	5.06	$5 80
Count Chaptal	12.45	3 68
Crespel	10.12	3 00
Cafler	12.145	2 65
Duke of Ragusa	10.12	3 36
General Preval	6.356	3 60
Masson	6.680	3 44
Audré	7.247	3 18
Grèvet-Pélé	10.777	2 50
Demars	15.222	4 00
Average	9.611	3 52

MANUFACTURE.

Name.	Number of days' work per annum.	Tons worked.	Yield in sugar, pounds.	Sugar per 100 of roots.	Cost.			Price paid for roots per ton.
					Total.	Per ton of roots.	Per pound of sugar.	
							Cents.	
Chaptal	120	600	....	3.0	.....	....	11.8	$4 00
M. de Dombaste	150	2,250	99,000	2	$27,656	$12 29	27	6 00
Duke of Ragusa	120	1,000	82,500	3.75	87,000	8 70	9.9	4 00
Crespel	.....	2,000	.....	5	.....	.....	5.6	3 00
Cafler	150	1,000	.....	.....	.....	.....	6	.....

Dubrunfaut determines from his own observations as the cost of production 5.2 cents per pound avoirdupois for the intermittent process, and 4.8 cents for the continuous. Colonial sugars were at this time worth 1.40 to 1.50 francs per kilogram or 12.7 to 13.6 cents per pound, and it was stated to be impossible to produce them at a cost of less than 5.5 cents per pound in the Antilles.

The above estimate of cost given by Dubrunfaut was for working about 1,000 tons per annum. For working double that quantity the net cost appears at that time to have been greater, and reached 5.8 cents for the intermittent process and 5.4 for the continuous process.

From this time the industry continued to spread rapidly, and to produce everywhere fruitful and profitable results, though, strange to say, no record seems to have been kept of the statistics of production in France until the year 1829, when it was stated at 4,000 tons.

In Germany the industry did not revive until after 1835, when attention was called to it by Krause of Austria, and Schubarth of Prussia, who went to France, the first in 1834 and the second in 1836, to study the progress and condition of the manufacture. As a consequence of these trips and the prominence given by the press of the information they carried home with them, the culture of the beet was inaugurated anew, factories were again erected in large numbers, and the industry soon became so powerful as to be competent to contribute to the revenue of the government.

CHAPTER II.

STATISTICS.

The departments of France in which the culture of the beet for the production of sugar is mostly confined, or where it is most active, are the Aisne, Nord, Pas-de-Calais, Somme, Oise, and Ardennes. Beets are grown for the production of sugar in the other departments, it is true, but the manufacture is carried on there to a limited extent as compared with those mentioned, and it is a rare exception to find it in any department south of the river Loire or east of the Saone. These facts are illustrated in the following table, showing the number of factories in existence and the quantities of sugar (in tons of 2,200 pounds) produced in the different departments in the campaign of 1877–'78:

Departments.	No. of factories.	Production.
		Tons.
Aisne	91	83,500
Nord	156	99,500
Pas-de-Calais	96	61,000
Somme	65	54,500
Oise	40	33,500
Ardennes	11	
Aube	2	
Cher	1	
Côte d'Or	4	
Eure	4	
Haute Marne	1	
Haute Saone	3	
Loiret	1	
Marne	6	
Meurthe-et-Moselle	2	
Meuse	1	58,000
Nièvre	1	
Puy-de-Dome	5	
Saône-et-Loire	3	
Seine Inférieure	1	
Seine-et-Marne	14	
Seine-et-Oise	9	
Deux Sèvres	1	
Eure-et-Loire	2	
Yonne	1	
Total	521	390,000
Rasping works	143	
Factories with rasping works	59	

This list is taken from the *Liste Générale des Fabriques de sucre*, published at the office of the *Journal des Fabricants de Sucre*, in Paris. The total number of factories given here varies considerably from that given in the official statistics of the condition of the industry in France and referred to as factories in active operation, which would seem to indicate the existence of a number of idle works.

From figures we have been able to obtain from various sources we have constructed the following table, showing the number of factories in existence and the quantities of sugar produced in France for the different years from 1835 to the present time. The portion of the table for the years 1840 to 1875, inclusive, was constructed by a writer in the

Journal des Fabricants de Sucre, and the figures for the subsequent years I have taken from various official reports. The figures of the table vary in some particulars from those given by other authorities, but they will serve to show the steadily increasing progress made by the industry during the time covered by the table.

Years.	Number of factories.	Sugar produced, in tons of 2,200 pounds.	Years.	Number of factories.	Sugar produced, in tons of 2,200 pounds.
1826–'27	.....	1,500	1853–'54	303	76,957
1827–'28	.....	2,200	1854–'55	208	44,669
1828–'29	.....	2,685	1855–'56	275	92,197
1829–'30	.....	4,380	1856–'57	283	83,126
1830–'31	....	7,000	1857–'58	341	151,514
1831–'32	.....	9,600	1858–'59	349	132,650
1832–'33	.....	12,000	1859–'60	334	126,479
1833–'34	.....	20,000	1860–'61	334	100,876
1834–'35*	.....	30,000	1861–'62	346	146,416
1835–'36	.....	40,000	1862–'63	362	173,677
1836–'37	.....	48,968	1863–'64	366	108,466
1837–'38	436	49,226	1864–'65	398	149,074
1838–'39	555	39,199	1865–'66	419	274,014
1839–'40	422	22,748	1866–'67	434	216,854
1840–'41	389	26,959	1867–'68	159	224,767
1841–'42	398	30,493	1868–'69	456	206,844
1842–'43	384	29,560	1869–'70	464	282,136
1843–'44	325	28,660	1870–'71	482	282,109
1844–'45	294	36,457	1871–'72	494	324,429
1845–'46	306	40,546	1872–'73	519	395,254
1846–'47	298	53,795	1873–'74	527	383,218
1847–'48	304	64,316	1874–'75	524	423,822
1848–'49	284	38,639	1875–'76	525	462,259
1849–'50	288	62,165	1876–'77	502	243,182
1850–'51	308	76,151	1877–'78	501	398,132
1851–'52	329	68,583	1878–'79	501	420,396
1852–'53	337	75,275			

* The figures for the years 1826–'27 to 1834–'35, inclusive were taken from the work of Prince Napoleon Louis Bonaparte, entitled "Analysis of the Sugar Question."—English translation.

The general statistics of manufacture of indigenous sugar in France for the years 1873, 1874, and 1875 are given in an official publication for the year 1875 as follows:

	1873.	1874.	1875.
Number of factories	532	543	539
Laborers employed	73,485	74,875	68,582
Force employed, horse-power	62,819	69,999	71,335
Production of sugar (tons)	409,916	423,222	463,122
Production of molasses (tons)	231,770	214,017	199,248
Total value of production	$54,185,704	$54,294,968	$54,425,757

In 1875 the laborers comprised 51,023 men, 9,367 women, and 8,192 children. These figures do not include all those employed in the fields in connection with the culture of the beet, though many of these become distributed there during the summer months when the factories are not in operation.

The next table will show the detailed statistics of culture of the beet in France for the year 1875, whether for sugar manufacture, for distillation, or for forage, and of the manufacture of sugar for the same year. It will explain itself.

Departments.	Arable land.	Total surface.	Area planted in beets.	Seed used per acre.	Average yield per acre.	Total production.	Value per ton.	Manufacture of indigenous sugar.						
								Establishments.	Labor.	Horse-power used.	Quantity produced in sugar.	Value.	Quantity produced in molasses.	Value.
	Acres.	*Acres.*	*Acres.*	*Pounds.*	*Tons.*	*Tons.*	*Dollars.*	*No.*	*No.*		*Tons.*	*Dollars.*	*Tons.*	*Dollars.*
Ain	659,026	1,433,000	8,873	6.30	9,477	46,216	5 14	90	13,497	17,258	80,351	9,071,673	24,457	853,802
Aisne	1,350,300	1,816,784	133,441	12.61	13,365	980,100	4 50							
Allier	1,068,307	1,806,002	9,985	5.95	11,097	60,896	4 72							
Alpes (Basses-)	376,545	1,718,477	1,435	7.12	10,125	7,988	9 00							
Ardèche	512,571	1,365,714	872	5.68	5,386	2,582	4 70							
Ardennes	776,509	1,293,121	19,697	10.23	11,745	127,137	3 90	13	1,940	1,150	9,700	1,008,800	3,300	96,060
Ariége	396,956	1,209,345	1,084	5.34	3,847	2,293	12 00							
Aube	899,585	1,483,029	10,685	6.23	13,041	76,578	5 00	2	360	625	1,170	212,400	275	8,000
Aude	562,187	1,560,091	187	7.12	10,125	1,045	2 00							
Aveyron	982,822	2,160,601	5,018	10.68	2,632	7,260	6 00							
Bouches du Rhône	407,817	1,261,486	1,514	5.96	2,511	2,090	6 40							
Calvados	760,687	1,364,248	11,120	5.78	10,125	61,765	4 12							
Charente	675,042	1,468,447	5,910	8.90	10,935	35,521	6 00							
Charente Inferieure	691,228	1,686,725	788	9.34	5,143	2,228	10 00							
Cher	951,923	1,779,059	10,554	6.17	14,782	87,390	4 10	1	216	450	900	100,800	337	10,400
Corrèze	539,171	1,449,594	2,224	8.90	14,175	17,325	10 00							
Côte d'Or	1,019,514	2,165,007	27,241	4.36	10,813	161,777	3 40	4	750	367	1,700	255,000	302	18,000
Dordogne	1,082,684	2,229,141	19,383	7.12	7,290	77,655	8 00							
Doubs	499,652	1,291,802	741	7.12	11,745	4,785	4 40							
Drome	730,173	1,611,568	5,238	11.57	2,288	6,646	13 00							
Eure	936,689	1,472,220	17,545	8.90	7,209	69,509	6 00	4	1,126	1,700	6,230	697,760	2,392	113,100
Eure et Loir	1,165,040	1,451,623	13,000	8.90	13,324	95,197	4 00	2	287	300	1,300	117,000	385	14,000
Finistère	767,149	1,661,020	12,921	4.45	12,150	86,278	4 00							
Gard	416,454	1,442,053	467	4.06	4,495	1,153	6 00							
Gers	755,097	1,551,954	148	4.45	8,100	660	4 00							
Gironde	605,224	2,406,972	1,655	8.90	10,327	9,396	5 00							
Hérault	254,119	1,531,611	378	3.56	4,050	841	4 00							
Ille et Vilaine	1,101,064	1,662,048	20,404	1.78	12,150	133,391	5 80							
Indre	879,684	1,679,215	6,911	8.90	12,393	47,673	3 00							
Indre et Loire	853,858	1,510,782	12,009	4.45	7,087	46,777	4 00							
Isère	895,109	2,048,414	5,154	5.27	15,330	21,339	4 50							
Jura	455,839	1,234,091	2,238	10.68	7,087	9,153	1 04							
Loir et Cher	820,968	1,569,403	5,068	3.92	9,315	2,594	15 32							
Loir	634,767	1,176,170	2,999	9.09	5,629	9,281	5 50							
Loire (Haute-)	518,714	1,226,242	840	11.57	4,050	1,870	4 36							
Loiret	1,031,529	1,673,257	11,280	5.34	12,069	74,820	5 30	2	365	665	1,610	177,100	412	11,250
Lot	691,858	1,287,895	2,471	8.90	11,340	15,400	4 00							

Departments.	Arable land.	Total surface.	Area planted in beets.	Seed used per acre.	Average yield per acre.	Total production.	Value per ton.	Manufacture of indigenous sugar.						
								Establishments.	Labor.	Horse-power used.	Quantity produced in sugar.	Value.	Quantity produced in molasses.	Value.
	Acres.	*Acres.*	*Acres.*	*Pounds.*	*Tons.*	*Tons.*	*Dollars.*	*No.*	*No.*		*Tons.*	*Dollars.*	*Tons.*	*Dollars.*
Lot et Garonne	744,720	1,323,040	11,441	4.45	12,150	76,395	10 00	.....	.....	.....	.....	.....	.....	.....
Lozère	490,558	1,277,514	172	1.33	10,530	1,001	9 60	.....	.....	.....	.....	.....	.....	.....
Maine et Loire	1,127,068	1,759,683	494	7.12	5,062	13,750	5 00	.....	.....	.....	.....	.....	.....	.....
Manche	884,721	1,464,987	2,794	7.12	7,573	11,632	9 40	.....	.....	.....	.....	.....	.....	.....
Marne	1,445,727	2,021,503	8,661	5.34	14,175	67,471	2 30	6	1,009	1,260	6,010	661,100	2,378	67,760
Marne (Haute-)	889,270	1,536,971	1,419	6.23	12,150	10,147	10 00	1	80	69	455	50,050	55	1,600
Mayenne	853,775	1,277,736	10,252	4.00	8,019	45,182	6 00	.....	.....	.....	.....	.....	.....	.....
Meurthe et Moselle	654,672	1,292,986	6,247	6.31	16,078	55,198	4 54	2	99	140	670	80,400	220	12,760
Meuse	895,900	1,538,995	6,555	14.24	7,816	28,161	4 00	.....	.....	.....	.....	.....	.....	.....
Morbihan	700,022	1,679,836	2,965	5.34	10,206	16,632	5 70	.....	.....	.....	.....	.....	.....	.....
Nièvre	860,175	1,684,469	10,020	6.67	11,340	62,557	4 50	1	138	75	316	34,760	88	3,200
Nord	935,490	1,403,824	10,094	14.17	18,225	192,092	3 20	165	18,586	22,354	148,863	15,481,762	25,789	750,251
Oise	1,040,005	1,446,869	7,109	12.26	14,742	562,101	3 86	42	5,946	9,990	38,935	4,127,110	11,048	331,124
Orne	867,373	1,506,727	2,456	3.56	13,729	18,543	1 60	.....	.....	.....	.....	.....	.....	.....
Pas de Calais	1,215,426	1,632,345	86,428	11.40	18,954	900,256	3 74	96	11,387	2,645	58,469	6,197,767	20,898	603,958
Puy de Dôme	1,025,502	1,964,684	7,413	7.21	13,770	56,100	4 00	5	900	400	4,500	522,060	1,650	60,000
Pyrénées (Orientales-)	211,959	1,018,632	296	8.90	14,175	2,310	6 00	.....	.....	.....	.....	.....	.....	.....
Rhine (Haute-) Belfort	47,253	150,774	177	12.46	4,617	451	7 40	.....	.....	.....	.....	.....	.....	.....
Saone (Haute)	664,846	1,319,570	3,375	5.34	14,215	26,370	14 10	2	83	355	567	67,012	.....	.....
Saone et Loir	1,079,410	2,113,257	14,429	8.90	10,530	83,497	4 10	5	685	950	6,000	720,000	1,155	58,800
Sarthe	1,044,119	1,533,759	7,215	3.11	6,075	24,090	12 30	.....	.....	.....	.....	.....	.....	.....
Savoie	240,355	1,423,254	1,210	7.12	6,075	3,932	6 40	.....	.....	.....	.....	.....	.....	.....
Savoie (Haute)	346,530	1,066,229	1,319	7.55	6,156	4,464	7 76	.....	.....	.....	.....	.....	.....	.....
Seine Inferieure	894,150	1,491,458	20,567	3.56	11,785	138,709	3 60	1	261	100	7,600	794,400	330	12,000
Seine et Marne	979,892	1,417,534	55,131	14.04	14,256	431,921	4 12	15	2,728	5,476	20,986	2,476,407	3,782	109,832
Seine et Oise	879,390	1,384,739	33,142	14.36	15,633	284,736	5 50	10	882	565	6,200	669,600	247	22,500
Sèvres (Deux-)	1,043,753	1,482,656	12,479	5.34	10,125	69,437	4 00	1	161	110	800	96,000	110	4,000
Somme	1,303,048	1,532,520	86,114	12.46	14,580	689,990	4 20	66	6,650	3,700	58,117	6,741,583	9,185	168,639
Tarn	887,708	1,418,969	542	5.34	11,137	3,932	8 00	.....	.....	.....	.....	.....	.....	.....
Tarn et Garonne	597,406	919,304	1,111	4.45	10,125	6,187	2 50	.....	.....	.....	.....	.....	.....	.....
Var	379,021	1,489,488	5	3.56	3,807	113	10 00	.....	.....	.....	.....	.....	.....	.....
Vaucluse	509,167	874,689	1,383	5.34	12,514	6,118	4 86	.....	.....	.....	.....	.....	.....	.....
Vendee	929,826	1,656,530	6,259	8.90	4,212	14,488	13 56	.....	.....	.....	.....	.....	.....	.....
Vienne	817,352	1,722,478	4,497	8.90	4,050	10,010	6 00	.....	.....	.....	.....	.....	.....	.....
Vienne (Haute-)	731,418	1,363,225	5,177	4.45	5,361	18,666	6 00	.....	.....	.....	.....	.....	.....	.....
Vosges	607,352	1,446,273	775	5.34	12,150	5,181	4 00	2	37	10	300	34,800	.....	.....
Yonne	1,178,772	1,835,574	21,852	6.45	11,947	143,477	6 00	1	309	630	771	84,851	350	19,140

CHAPTER III.

METEOROLOGY AS APPLIED TO BEET-ROOT CULTURE—CONDITIONS MOST FAVORABLE—COMPARISON OF CONDITIONS IN THE BEET-GROWING DISTRICTS OF EUROPE—LIMITS OF CONDITIONS GOVERNING THE EXTENSION OF THE CULTURE—LOCATION OF SECTIONS OF FAVORABLE CONDITIONS IN THE UNITED STATES—CONCLUSIONS.

In the meteorological conditions of various sections we believe will be found the most important influences that have a bearing upon the limits to the extension of the industry we have under consideration. In establishing the culture of the beet and the manufacture of sugar therefrom, much of course depends upon the social and commercial relations of a community, but these are to some extent variable according to the desire of the population composing the community, and may be modified by human influences. Deficiencies in the physical or chemical characters of soils may be modified by the application of human intelligence, skill, and labor, but the influences which may affect the culture of the beet for good or evil, and over which we have no control, are those which constitute the subject for consideration in the present section of this report. In this branch of the subject there is nothing to be done but to make a comparison of the conditions of the section in which an attempt at the culture is contemplated, and those of sections in which the industry is most prosperous, and enter into or abandon the enterprise, according to the results of the comparison as they are favorable or otherwise.

The principal conditions to be studied in this connection are very naturally those of temperature and moisture with which the plant may be surrounded, and we are perfectly aware that, in order to make this work complete, the examination and comparison of the conditions abroad and at home should be much more extended and exhaustive than we have been able to make on account of the various limitations to which we have been subject. However, the results we may here make public will not be without value as a guide to those desiring to attempt establishing the production of sugar from the beet root in any portion of the United States or, indeed, elsewhere.

The amount of moisture at the disposition of the plant at all seasons of its growth is the most important factor in its normal development that will affect to any marked extent the quantity and quality of the crop and consequently the existence and progress of this culture.

Temperature has an influence it is true, but, except it be too low, it has not the same power for evil that deficiency of moisture may have, and we have nothing to fear concerning too low a temperature during the growing season in the United States. In fact, the plant is more likely to suffer from too high a temperature during the summer months than from a deficiency of heat.

In determining whether a section be favorable to the culture it is, of

course, of importance to note whether the temperature is sufficiently high to insure the development of the plant, and, after this, note must be taken of the rainfall with which the section is favored during each month. It is not sufficient to know that the quantity is equal to or above a certain average, but that it be regularly supplied, and also that the temperature is not sufficiently high to evaporate it before it can be made use of by the plant. In this study, therefore, it is desirable that we take into consideration as factors the average temperature, rainfall, humidity, and number of rainy days for each month during the growing season.

Upon consulting the map of the European states showing the location of beet-root culture, we find it generally concentrated toward the north. But, in the study of the meteorological conditions, we find that the quantity of rainfall during the year is greater in the south than in the north, and yet in the former section vegetation seems to suffer more from want of moisture than in the latter. Marié Davy justly explains this by referring it to the evaporation due to a higher temperature, more direct sunlight, and a less number of days upon which rain falls. Thus he says:*

Generally, rains are less numerous, more abundant, and less disseminated in the south than in the north. It rains longer and more frequently in the neighborhood of the coasts than in the interior; and, finally, mountains are a cause of increase in the total annual rainfall, especially upon sides exposed to winds from the sea. The south of France, therefore, receives more of water in rains than the north, but the rains are less frequent. The temperature being higher, the atmosphere contains more of aqueous vapor, with equal degrees of the hygrometer, and, when the condensation of moisture takes place, it furnishes a larger quantity. But the condensations are more rare, and, as the evaporation is very active, the periods of drought are long and sometimes very intense. Sections bordering on the ocean and the channel are more frequently rainy than the interior. * * * The French coast of the Mediterranean forms an exception to this rule. Here the annual rainfall is but 0.60 meter (23.6 inches) notwithstanding their southern position. This is because the rainy winds of the center of France reach the basin of the Mediterranean only after passing the Cevennes Mountains, where they lose the greater portion of their water.

Concerning evaporation the same writer says:†

It is the reverse of rainfall. This phenomenon varies widely according to times and places. If we consider first the annual average by regions, we obtain the results summed up below:

	Inches.
Plains of the north of France	24.4
Plains of the west of France	26.7
Plateau of the central region	34.25
Southern France	87.79

Whether these relations be the sole influence tending to confine the beet culture of France to the limits mentioned above or not, it will be of interest to see what are the conditions most suitable to the culture as determined by observation, and what are the conditions recorded for the

* *Meteorologie et Physique agricoles, Paris,* 1875, p. 190. † Ibid, p. 193.

sections in which the industry has secured firm footing and has become a source of profit to those engaged in it. But before proceeding to the discussion of the records we desire to call attention to the notions concerning the conditions found by observation to be most favorable to the crop both as to the production of quantity and of quality.

In this connection Briem* considers that—

> The temperature of the soil should be at least 50° F. at the time of sowing. A warm month of May favors germination. A dry hot July makes the roots run to seed; rainy August gives weight; dry September increases the sugar, while a wet September produces the opposite effect. From May to the middle of June should be warm and tolerably moist, with a day temperature of 60° to 65° F. June and July should be relatively cool and rainy, with a day temperature of 65° to 67° F. August and September should be warm and relatively dry with an average temperature of 64.5° to 67.5° F. October cool and fresh with an average temperature of 47.7°.

The sum† of degrees of heat required for production of sugar is divided as follows, in round numbers: April, 1,370; May, 1,840; June, 1,980; July, 2,140; August, 2,030; September, 1,840; October, 1,530—total, 12,730 degrees Fahrenheit in seven months.

Basset‡ gives figures for sum total of degrees of heat required for production of sugar which do not vary much from those of Briem.

Dr. Kohlrausch§ says: "Among the labors and studies having in view the law presiding over this plant (the beet-root) the meteorological conditions are with this regard well worthy of attracting our closest attention."

Dr. Joseph Hanaman has just published the results of observations of 1877 at the station of Lobositz, of which he is director. The temperature and the atmospheric conditions were very favorable in 1877, as well for the normal development of the plant as for the formation of sugar. Thus the year 1877 may be counted upon as one of the best of the last decennial periods. The last months of growth were eminently proper to facilitate maturation of the roots, the saccharine content and purity of which were exceptional. The month of September was constantly dry, except toward the last days, and the nights were cool.

Dr. Hanaman says: "The influence of the temperature explains the exceptionally high polarizations and remarkable purity of the beet of 1877. Lobositz beets of that year varied in richness between 13.51 and 15.64 per cent. of sugar, with a quotient of purity of 80.4 and 92.7."

The observations of Hanaman correspond with those of Deherain, who, by comparing the yields obtained in his experiments of 1875, 1876,

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*Journal des Fabricants de Sucre, October 23, 1878.

†This is determined by multiplying the daily average of temperature by the number of days in the month.

‡Guide Pratique du Fabricant de Sucre, 1872, vol. i, p. 419.

§Journal des Fabricants de Sucre, 1878, March 27.

and 1877, and the temperature and rainfall from September 15 to October 15 of the same years, found the following relations:

Years.	September 15 to October 15.		Observations.
	Average temperature.	Rainfall.	
		Inches.	
1875	58°.7 Fahr	2.64	Poor beets.
1876	59°.4 Fahr	2.17	Do.
1877	51°.3 Fahr	0.45	Rich beets.

We now come to the consideration of the meteorological conditions actually existing in the beet-growing districts of Europe, from a comparison of which with those of a similar character in our own country, we must determine those sections in which we may enter into the prosecution of the industry with the greatest probabilities of success.

A very clear notion of the general conditions of temperature and rainfall prevailing in the beet-growing districts of Europe may be obtained from the table of curves given in the lower right-hand corner of the European map.

The curve of rainfall for the north of France and Germany is copied from a table of curves given by Marié Davy;* and the curves of temperature and rainfall for Cambrai, located in the midst of the beet-growing district of France, and for Halle, situated in the most important sugar-producing section of Germany, are plotted from our own compilations.

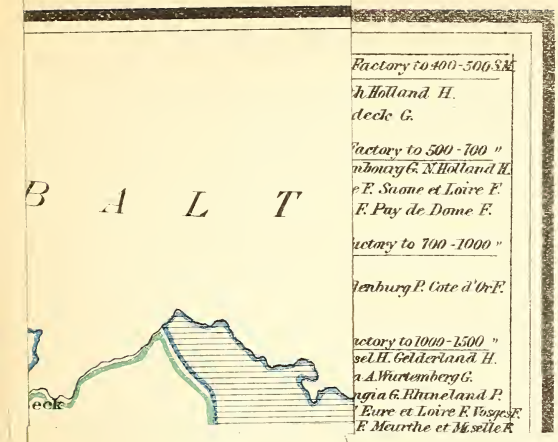
From these we see how closely the deductions made from a study of the recorded conditions compare with those arrived at by Briem, Hanaman, and Deherain, from their cultural experiments and observations.

It was our intention when starting out with this work to confine the meteorological researches to the conditions of France, but the paucity and irregularity of the records of the climatic conditions of that country forced us to look to other countries for the data we required. In this connection we find the records of Belgium, cared for by the illustrious Quételet, more complete in all particulars than those of any other country. From them, as given in his "*Météorologie de Belgique*," we have constructed the following tables that will explain themselves:

Average temperatures in Belgium for the different months.

Places.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Bruxelles	35.96	38.12	41.90	48.56	56.12	63.14	64.94	64.40	59.00	51.98	42.80	38.12
Alost	32.90	36.68	41.36	46.94	56.30	64.22	67.28	65.84	58.82	50.00	42.80	35.60
Gand	33.62	35.78	41.54	50.72	59.90	67.28	68.90	67.82	60.26	50.90	40.82	35.96
Ostende	36.32	37.94	42.44	49.28	56.84	61.34	64.04	64.04	60.98	53.24	43.52	38.66
Louvain	32.18	35.06	49.46	48.56	57.02	62.96	64.58	64.22	57.92	49.64	42.44	27.86
St. Trond	35.42	39.20	39.38	48.38	56.66	62.60	65.84	63.86	57.56	51.08	42.98	37.40
Liège	34.84	36.68	41.00	48.74	57.38	64 22	66.56	65.84	58.82	51.80	40.82	37.22
Namur	34.88	35.96	39.74	47.84	56.12	63.86	66.02	64.58	56.84	50.78	40.28	36.86
Stavelot	32.18	32.90	37.22	46.04	55.04	63.86	65.48	63.86	54.86	48.74	37.58	33.80
Arlon	36.32	35.24	39.02	39.92	48.20	57.20	62.42	55.94	53.42	40.46	32.90	33.80

* Météorologie et Physique Agricoles.


Factory to 400 - 500 S.M.
h Holland H.
decle G.
Factory to 500 - 700 "
nbourg G. N. Holland H.
e F. Suone et Loire F.
F. Puy de Dome F.
actory to 700 - 1000 "
lenburg P. Cote d'Or F.
actory to 1000 - 1500 "
sel H. Gelderland H.
a A. Wurtemberg G.
agia G. Rhineland P.
Eure et Loire F. Vosges F.
F. Meurthe et M.selle F.
B A L T
eek

MAP
of the
Beet Growing Districts
of
FRANCE, GERMANY & AUSTRIA.
Showing

1st The relation of the number of Factories to the Square miles of surface in each State Department or Province

2nd A line passing through stations for which the maximum average temperature recorded for either July or August is 70° F

Explanation

One Factory to 10-20 Sq Miles
Nord F. Hainault B.

One Factory to 20-30 Sq Miles
Pas de Calais F.

One Factory to 30-50 "
Aisne F. Somme F.
Anhalt G.

One Factory to 50-100 "
Sachsen G. Brunswick G.
Oise F. Liege B.

One Factory to 100-200 "
Ardennes F. Seine et Marne F.
Brabant B. East Flanders B.
Limburg B. North Brabant H.

One Factory to 200-300 "
Namur B. Luxery B. W. Flanders B.
Moravia A. Silesia A.
Hanover G. Seine et Oise F.

One Factory to 300-400 "
Silesia P. Bohemia A.
Zeeland H.

One Factory to 400-500 "
South Holland H.
Waldeck G.

One Factory to 500-700 "
Luxembourg G. N. Holland H.
Marne F. Seine et Loire F.
Eure F. Pay de Dome F.

One Factory to 700-1000 "
Brandenburg P. Cote d'Or F.

One Factory to 1000-1200 "
Oberyssel H. Gelderland H.
Galicia A. Wurtemberg G.
Thuringia G. Rhineland P.
Indre F. Rhone et Loire F. Vienne F.
Loiret F. Meurthe et Moselle F.
Nievre F. Haute Saone F.

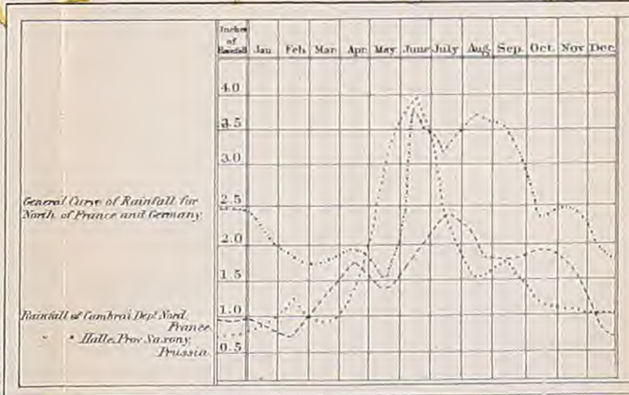
One Factory to 1200-2000 "
Pommerania P. Lauenburg A.

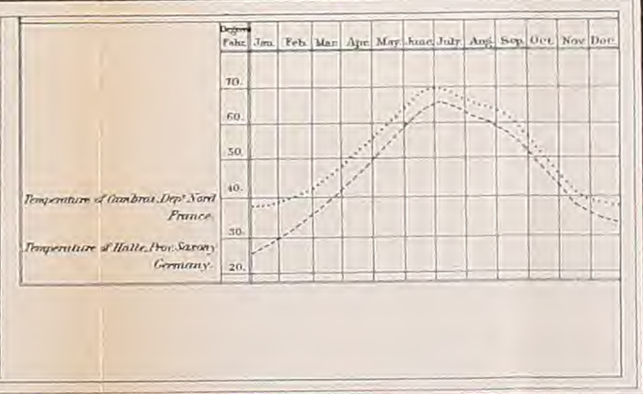
One Factory to 2000-3000 "
Aire F. Haute Marne F.
Seine inferieure F. Deux Sevres F.
Meuse F. Yonne F.

One Factory to 3000-4000 "
Hessia P. Schleswig P.
Westphalia P.

One Factory to 4000 or more
Hungary A. Bavaria G.
Baden G. Rh. W. Prussia.

A. Austria B. Belgium F. France G. Germany H. Holland P. Prussia





Drawn by Geo Mant

Average humidity in Belgium for the different months.

Places.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Bruxelles	87.3	83.5	73.5	65.9	64.2	64.8	66.8	68.3	73.7	80.4	85.2	89.0
Gand	91.0	88.7	81.9	75.0	69.3	68.1	68.9	71.2	78.1	83.3	88.0	90.4
St. Trond	89.2	88.4	85.4	78.8	71.8	75.0	71.2	78.6	83.8	84.4	88.8	92.0
Liège	85.0	86.5	85.0	83.5	81.0	69.0	75.0	82.5	87.0	89.5	85.0	90.5
Stavelot	92.3	91.4	85.8	77.7	74.6	75.3	76.9	80.4	85.0	89.8	90.3	92.2
Namur	91.5	87.0	85.0	79.4	75.6	74.1	77.2	78.3	85.2	87.8	88.8	90.4

Relation between the numbers of years above the average and those below it.

Places.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Gand	7-6	8-6	4-10	8-6	8-6	7-7	7-7	6-8	7-7	4-10	2-12	7-6
St. Trond	3-2	3-2	3-2	4-1	2-3	2-3	2-2	3-2	2-3	3-2	3-2	2-3
Liège	1-1	1-1	1-1	1-1	1-1	1-1	1-1	1-1	1-1	1-1	1-1	1-1
Stavelot	6-5	4-7	5-6	4-7	3-8	5-6	3-8	4-7	4-7	6-5	5-6	4-7
Namur	2-4	2-4	4-2	2-4	3-3	3-3	3-3	3-3	3-3	3-3	3-3	2-4

Number of rainy days for the different months—average of a series of years.

Places.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Bruxelles	14.8	12.1	14.7	14.3	14.9	15.6	16.2	15.3	14.7	17.3	16.1	15.3
Gand	14.0	10.7	14.2	14.6	15.7	15.4	17.0	15.6	14.9	17.1	15.7	13.6
Alost	10.8	10.6	13.4	10.2	13.8	15.0	16.2	10.4	15.8	13.0	17.0	11.6
Louvain	12.3	10.8	15.5	14.7	16.4	16.7	18.1	17.9	13.7	17.7	17.6	12.7
St. Trond	10.7	10.3	11.7	18.0	12.5	15.2	12.5	15.7	13.3	13.5	13.5	10.2
Namur	14.3	9.8	13.6	14.0	14.9	16.1	14.4	14.0	14.9	16.0	14.0	14.9
Liège	13.7	10.9	13.4	16.6	17.1	15.7	15.8	16.2	15.2	15.9	14.6	13.6
Stavelot	12.5	7.8	8.9	12.8	15.9	15.5	15.6	14.9	13.7	15.0	10.6	11.7

Relation between the number of years for which the recorded figures are above the average and below it, as shown by the observations of a number of years.

Places.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Gand	12-14	12-14	15-11	7-19	13-13	12-14	11-15	14-12	15-11	12-14	10-16	11-15
Alost	3-3	3-2	5-1	3-3	3-3	3-3	4-2	4-2	4-2	1-5	3-3	3-3
Louvain	5-7	6-6	6-6	6-6	7-5	5-7	4-8	6-6	5-7	7-5	6-6	6-6
St. Trond	4-2	3-3	4-2	3-3	1-5	3-3	3-3	2-4	4-2	4-2	3-3	3-3
Namur	5-8	7-6	7-6	8-5	6-7	7-6	7-6	7-6	4-9	5-8	7-6	6-7
Liége	8-8	8-9	9-8	9-8	12-5	6-11	7-10	10-7	10-7	6-11	9-8	8-9
Stavelot	5-6	6-5	6-5	5-6	7-4	6-5	4-7	6-5	5-6	5-6	5-6	6-5

Average monthly rainfall in Belgium expressed in inches.

Places.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Bruxelles	2.19	1.85	1.96	1.99	2.23	2.64	2.69	2.84	2.39	2.64	2.38	2.14
Gand	2.30	1.82	1.89	1.92	2.32	2.94	2.91	2.97	2.87	2.84	2.59	2.43
Alost	2.77	1.95	1.94	1.57	1.98	3.63	3.38	2.68	2.75	2.32	3.68	2.02
Liége	2.10	1.96	1.88	2.52	2.66	2.81	2.53	3.31	2.63	2.60	2.18	2.43
Namur	1.92	1.24	1.41	1.89	2.14	2.18	2.05	2.40	2.17	1.99	1.66	1.97
Louvain	2.22	2.14	1.98	2.00	2.15	3.05	2.64	3.05	2.31	2.34	2.81	1.82
St. Trond	1.97	2.10	1.66	2.95	2.38	2.43	1.98	3.70	2.17	2.78	1.76	1.72
Stavelot	2.92	3.03	2.48	3.31	3.07	3.23	3.16	3.50	3.16	3.01	2.73	3.20

Relations between the number of years in which the rainfall of the different months is below 2 inches (50.5^{cm}) *and of those in which it is above that figure.*

Places.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Bruxelles	12–18	17–13	19–11	15–15	18–12	11–19	8–22	8–22	12–18	11–19	12–18	13–17
Gand	10–15	14–12	16–10	14–12	9–17	7–19	7–19	5–21	6–20	9–17	9–17	12–14
Alost	1–4	3–3	5–1	4–2	3–3	1–5	1–5	2–4	2–4	2–4	1–5	5–1
Liége	8–9	10–7	11–6	6–11	5–12	3–14	4–13	5–12	7–10	6–11	7–10	7–10
Namur	6–7	10–3	10–3	8–5	7–6	6–7	6–7	7–60	6–7	8–5	9–4	7–6
Louvain	5–7	6–6	7–5	7–5	6–6	5–7	5–7	2–1	4–8	7–5	2–10	8–4
St. Trond	2–4	3–3	4–2	1–5	3–3	3–3	3–3	1–5	4–2	2–4	4–2	4–2
Stavelot	4–7	5–6	5–6	2–9	1–10	2–9	0–11	1–10	4–7	4–7	2–9	3–8

These tables show certain relations that it will be eminently advisable to notice in the determination of localities favorable to beet-root culture. For instance, we see that the maximum average of temperature will not exceed 70° Fahrenheit; that the minimum average of monthly rainfall for the summer months is never below 2 inches; that the averages for the number of rainy days during the different months do not fall below 10; that during the summer months the averages are even above 15, and that the number of years in which the figures recorded are above the average is proportionally greater than the number of years in which they are below the average. And if it were possible to obtain the same extent of figures for the other countries where the industry of beet culture and sugar manufacture is distributed and is prosperous, the relations would doubtless be found to be closely comparable with those we have just given. It is to be regretted, in connection with the matter of the introduction of the culture in the United States, that we cannot quote tables of records showing the average number of rainy days in our country, for it has an undoubted influence upon the value of the crop.

We may now examine the conditions prevailing in other beet-producing sections of Europe, as shown in the following tables we have been able to compile from the works of Quételet, Dove, Marié Davy, Jelenek and Fritsche, and from the *Atlas de l'Observatoire de Paris*, the *Annuaire de la Société Météorologique de France*, and the *Bulletin de la Bureau Centrale de Météorologie* at Paris.

As before stated, the number of stations in France for which we were able to obtain averages or to find data sufficient to calculate averages from are very limited, yet the figures we present will serve to show the coincidence of the conditions in the sections in which the culture has been so long established, and these and the other records of the table, taken in connection with the map showing the location of the culture of the beet, will form a subject of interesting study, and are of value for comparison in the selection of sections of other countries that will be suitable, so far as the meteorological conditions are concerned, for the introduction of the industry with chances of success and profit.

TABLE SHOWING THE MONTHLY AVERAGES OF TEMPERATURE AND RAINFALL THROUGHOUT THE BEET-GROWING DISTRICTS OF EUROPE, IN DEGREES AND INCHES.

BOHEMIA.

Months.	Hohenfurth.		Krumau.		Budweis.		Winterberg.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	22.95	.50	30.20	.57	28.24	.34	28.40	.72
February	25.90	.35	33.75	.34	26.17	.52	33.80	1.02
March	34.61	.66	41.63	.76	36.80	.60	36.86	.47
April	43.30	.75	48.16	.59	49.71	.92	45.57	1.10
May	53.60	1.16	60.53	1.25	54.55	.72	62.76	.94
June	59.86	2.00	66.70	1.50	60.24	2.08	59.88	1.90
July	63.21	1.96	66.20	1.64	66.76	2.06	66.92	2.04
August	61.14	2.16	68.16	1.10	61.43	1.69	67.67	1.20
September	52.21	1.19	60.65	1.01	58.87	.98	56.42	.59
October	44.56	.92	51.00	.78	46.81	.30	47.42	1.37
November	33.78	.93	40.71	.59	35.44	.55	39.70	1.28
December	27.57	.58	36.41	.52	28.08	.30	34.57	1.47

Months.	Rehberg.		Stubenbach.		Schüttenhofen.		Neu-Bistritz.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	21.94	2.77	24.35	2.42	27.09	.46	22.12	.92
February	26.80	1.79	31.91	5.82	34.09	.63	26.62	.41
March	33.69	3.05	33.34	1.73	38.19	.72	33.40	.81
April	41.02	1.90	45.44	5.00	45.95	.82	42.89	1.14
May	50.34	2.65	54.15	2.09	55.33	1.98	52.36	.96
June	56.98	3.05	61.77	3.89	59.68	2.09	57.45	1.70
July	59.41	3.14	61.12	3.22	62.94	1.35	61.16	1.12
August	57.81	2.14	60.76	2.00	63.16	1.97	58.73	1.55
September	52.16	1.41	47.97	2.19	58.73	1.11	53.20	1.60
October	43.52	1.71	41.84	4.10	49.62	.66	43.43	1.09
November	34.68	2.89	29.97	2.56	40.66	.79	32.29	1.08
December	26 55	2.85	31.83	3.25	33.87	.56	26.73	2.23

Months.	Brzecznitz.		Strakonitz.		Pilsen.		Brzina.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	24.30	.81	33.44	48	24.35	.43	30.41	.42
February	28.38	.54	30.04	.94	28.06	.47	32.12	.23
March	36.84	.77	32.23	1.11	38.30	.34	38.92	.33
April	47.35	.82	45.10	.77	48.31	.77	49.63	.71
May	55.09	1.17	58.62	1.12	57.52	1.05	59.68	1.35
June	60.31	1.80	64.50	2.24	62.94	1.47	64.13	1.43
July	64.15	1.05	66.11	1.38	66.45	1.14	66.83	1.32
August	61.97	1.46	66.47	1.55	65.10	.96	66.52	1.32
September	55.38	1.02	57.22	.48	58.30	.81	59.46	1.08
October	46.92	.41	45.88	.33	48.11	.64	50.79	.45
November	36.86	1.08	41.75	.80	37.06	.49	40.60	.46
December	33.13	1.12	30.67	.42	31.59	.36	32.36	.62

Table showing the monthly averages of temperature and rainfall, &c.—Continued.

BOHEMIA.

Months.	Teplitz.		Deutschbrod.		Karlstein.		Pürglitz.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	22.71	.63	24.75	.74	32.99	.48	30.44	.43
February	27.07	.56	28.62	.45	32.66	.24	30.05	.40
March	34.75	.84	35.92	.69	43.14	.58	38.28	.32
April	43.79	.66	45.39	.88	53.87	.50	48.61	.62
May	50.88	1.10	54.75	1.02	64.00	1.58	57.83	1.06
June	56.48	1.14	61.54	1.66	69.00	1.57	64.50	1.44
July	60.44	1.12	64.15	1.48	71.76	1.00	65.08	1.21
August	58.84	1.16	61.99	1.36	68.38	.67	63.55	1.02
September	52.93	1.03	56.48	.87	63.95	.76	54.55	.59
October	45.01	1.11	47.73	.70	50.50	.39	50.18	.62
November	35.02	.92	37.90	.72	43.07	.53	40.44	.52
December	29.79	.91	29.37	.71	32.17	.18	32.71	.29

Months.	Smetschna.		Saatz.		Libolitz.		Schössl.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	24.93	.53	25.88	.37	27.39	.44	25.20	.43
February	28.69	.28	31.14	.20	29.59	.32	28.80	.45
March	36.19	.45	39.54	.78	29.86	.33	29.37	.37
April	45.79	.55	47.80	.87	45.55	.27	41.63	.48
May	55.29	.99	57.85	.83	33.04	1.27	53.49	1.16
June	62.44	1.05	62.85	1.16	61.97	1.23	62.31	1.17
July	65.46	1.08	67.15	1.39	63.25	1.26	63.39	1.10
August	63.52	.79	64.83	1.02	63.23	.82	60.10	1.03
September	57.11	.81	58.44	1.09	57.27	1.33	56.64	.68
October	47.44	.44	49.42	.28	44.49	.81	44.85	.55
November	37.36	.57	37.54	.94	41.50	.71	36.55	.48
December	29.68	.54	32.79	.57	16.41	.22	24.75	.29

Months.	Czaslau.		Prag.		Zlonitz.		Leitmeritz.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	32.92	.32	27.61	.35	25.74	.27	26.28	.60
February	31.08	.57	31.39	.26	30.13	.32	30.47	.45
March	39.60	.34	40.87	.36	39.47	.33	37.22	.52
April	50.12	.64	52.61	.49	48.81	.47	47.53	.57
May	59.50	1.08	60.49	.77	52.28	.72	58.37	1.03
June	64.22	.94	65.95	1.05	63.23	1.59	64.29	1.40
July	69.10	1.06	69.62	.92	66.83	.96	66.56	1.39
August	63.86	1.42	68.56	.84	64.45	.92	66.00	.98
September	61.97	.72	61.81	.57	59.43	.62	59.09	.69
October	52.19	.65	50.29	.36	50.50	.42	48.97	.81
November	41.50	.52	39.92	.45	39.11	.47	39.11	.66
December	31.87	.24	33.53	.37	34.79	.34	29.84	.55

Months.	Landeskron.		Senftenberg.		Konigsgratz.		Teutsch.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	23.13	.92	30.31	.93	24.75	.80	29.28	.48
February	27.70	.57	30.25	1.22	25.54	.52	28.18	.54
March	35.94	.86	32.20	.88	35.62	.67	38.64	.37
April	45.07	.84	43.63	1.02	44.62	1.03	48.38	.73
May	56.05	1.52	57.27	.97	54.61	1.15	59.01	1.50
June	62.69	1.74	64.41	1.85	62.47	1.40	66.02	.97
July	65.73	1.50	65.55	1.50	65.19	1.33	68.05	.76
August	63.25	1.24	64.72	1.84	61.99	1.43	67.82	.92
September	56.01	1.02	56.10	1.24	57.02	.91	60.06	.45
October	47 23	.73	51.00	1.13	47.44	.71	45.97	.76
November	36.91	1.05	34.66	.91	36.16	.82	39.90	1.19
December	29.23	1.02	30.39	.98	29.50	.79	33.15	.93

Table showing the monthly averages of temperature and rainfall, &c.—Continued.

BOHEMIA.

Months.	Reichenau.		Trautenau.		Hohenelbe.		St. Peter.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	28.14	.12	29.13	1.12	24.01	1.51	23.27	.68
February	33.95	.19	28.65	1.25	27.09	1.12	26.08	1.14
March	34.34	.27	31.86	.87	33.57	1.27	33.26	1.40
April	46.00	.32	46.47	.99	42.82	1.10	43.50	1.49
May	55.52	.34	56.89	1.95	52.43	1.13	49.19	.88
June	62.89	.65	64.00	1.37	58.39	1.49	55.36	2.45
July	63.84	.63	66.16	2.71	60.96	1.52	59.70	2.75
August	61.25	.33	65.37	2.67	59.52	1.53	57.07	2.32
September	56.28	1.04	57.04	.61	54.41	1.10	51.89	1.83
October	51.06	.94	52.03	1.15	46.22	1.22	44.47	1.06
November	34.47	.....	32.14	.78	34.99	1.51	32.70	1.32
December	30.72	.42	28.54	1.51	29.12	1.55	27.34	2.02

WESTPHALIA.

Months.	Emden.		Lingen.		Loningen.		Münster.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	34.41	1.85	32.18	1.84	32.11	2.14	33.33	2.41
February	31.37	1.50	33.86	.95	33.81	.16	37.51	1.63
March	37.69	.75	39.38	1.41	38.73	1.98	39.90	1.06
April	50.86	.88	47.78	1.39	43.75	1.51	47.46	2.36
May	54.24	2.24	57.18	3.32	57.40	.....	55.87	3.41
June	59.74	2.93	64.67	2.60	64.60	.....	60.96	3.40
July	61.27	3.67	66.70	4.61	66.63	.....	63.25	2.57
August	60.10	3.15	65.19	3.58	65.01	4.28	62.51	2.79
September	59.16	2.15	58.71	1.19	58.42	2.00	57.85	2.00
October	51.06	2.78	52.82	1.99	52.57	.73	50.02	3.44
November	42.22	2.04	40.82	2.49	40.56	3.35	42.64	2.01
December	25.27	2.61	34.77	1.63	34.14	1.86	37.09	2.35

Months.	Gütersloh.		Paderborn.		Salzuflen.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	31.54	2.39	32.31	1.72	31.82	1.68
February	34.25	1.66	38.33	1.59	38.80	2.30
March	41.05	1.86	40.44	1.46	44.20	1.35
April	49.71	1.93	49.65	1.92	51.17	1.71
May	58.28	2.20	57.30	2.77	59.32	1.91
June	64.60	2.73	64.90	3.21	65.57	2.53
July	66.54	3.18	66.90	3.10	68.06	1.75
August	66.30	2.95	66.02	3.60	66.09	2.62
September	60.15	2.25	60.17	2.14	61.52	2.21
October	52.02	2.64	54.08	2.23	53.25	2.10
November	43.82	2.30	42.22	2.54	43.57	1.93
December	38.40	2.28	38.64	2.24	41.03	1.56

Table showing the monthly averages of temperature and rainfall, &c.—Continued.

AUSTRIA.

Months.	Kremsmunster.		Linz.		Gresten.		Melk.		Korneuburg.	
	Temp.	Rainfall.	Temp	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	26.28	.92	31.21	.60	28.67	.....	31.64	.22	32.05	.44
February	28.49	.91	32.14	1.01	29.68	.82	31.38	.26	32.47	.39
March	36.91	1.02	38.69	.43	37.67	.58	39.45	.05	40.82	.19
April	47.17	1.06	50.16	.76	51.10	.50	53.27	.....	52.14	.28
May	53.31	1.43	60.69	1.06	60.73	1.69	61.07	.93	60.51	.93
June	61.03	2.15	67.62	1.69	66.94	4.71	70.32	1.85	69.55	1.43
July	64.40	2.28	70.75	1.55	66.47	3.66	69.85	2.59	68.29	1.67
August	63.28	2.08	69.00	1.19	66.66	1.88	69.64	.70	69.58	1.21
September	56.48	1.25	61.12	.36	59.34	.33	61.93	.96	59.61	.....
October	46.78	1.14	53.35	.77	53.35	.35	55.47	.24	50.45	.76
November	37.02	.95	39.45	.54	32.11	.....	34.02	.....	39.38	.60
December	30.20	.96	38.50	.56	29.68	.....	32.25	.....	32.41	.46

Months.	Kahlenberg.		Wien.		Brünn.		Oderberg.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	27.50	.82	32.41	.53	20.19	.50	31.71	.49
February	32.05	.38	35.36	.45	34.99	.44	29.55	.55
March	33.93	.26	43.30	.42	39.49	.45	32.72	.62
April	50.61	.24	53.99	.54	55.99	.49	47.91	.47
May	58.80	1.57	64.02	.73	63.50	1.02	58.60	1.28
June	67.75	1.28	69.69	1.09	61.25	1.05	64.41	1.75
July	66.88	3.03	72.98	.86	66.76	.99	67.89	1.43
August	70.50	.55	72.10	.97	72.50	1.03	66.72	2.22
September	57.20	.29	61.70	.60	59.74	.61	58.58	.36
October	54.57	1.00	54.17	.62	50.74	.65	53.87	.61
November	38.82	.63	43.30	.53	41.00	.70	32.47	1.59
December	30.02	.90	32.53	.44	30.65	.37	29.82	.43

GALICIA.

Months.	Czernowitz.		Jalso.		Stanislau.		Lemberg.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	27.31	.89	27.37	2.33	22.78	.84	24.33	1.20
February	24.79	1.39	25.09	1.54	27.35	.96	27.39	1.13
March	32.23	1.42	32.23	1.40	31.54	1.27	32.17	1.56
April	49.37	2.20	49.82	1.94	48.32	1.72	47.48	1.73
May	61.77	2.03	59.18	3.55	60.15	2.90	58.75	3.41
June	67.37	4.56	68.23	2.33	66.59	3.34	64.52	3.93
July	70.09	5.61	68.48	3.80	68.50	3.87	67.49	3.43
August	68.48	2.80	67.53	1.92	68.32	3.37	66.49	3.01
September	57.22	1.15	58.75	2.36	57.81	2.45	59.27	1.64
October	54.79	1.31	57.23	1.63	50.79	2.12	50.57	1.55
November	34.61	1.70	32.11	.59	39.02	1.44	38.64	1.47
December	29.56	1.03	29.52	1.20	27.27	1.11	27.34	1.53

Months.	Rzecow.		Saybush.		Wadovice.		Krakau.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	29.52	1.38	.....	1.28	25.12	1.55	25.02	.86
February	25.05	1.79	.....	2.17	27.30	1.17	29.06	1.25
March	32.23	.94	.....	2.13	41.10	1.89	38.28	1.15
April	48.25	2.29	.....	1.82	48.38	2.15	50.01	.84
May	59.96	2.55	.....	2.81	57.52	3.68	61.23	1.34
June	63.84	2.83	.....	4.26	64.34	5.26	67.58	2.51
July	69.00	3.95	.....	6.45	61.72	4.13	68.50	3.02
August	68.20	3.74	.....	5.58	61.25	2.38	68.05	2.25
September	59.88	2.63	.....	2.02	59.79	4.08	60.64	1.73
October	56.87	1.40	.....	1.06	52.00	3.57	51.90	1.36
November	32.90	.79	.....	1.59	32.13	1.92	39.59	1.30
December	27.28	1.57	.....	.71	29.62	1.82	29.09	1.20

Table showing the monthly averages of temperature and rainfall, &c.—Continued.

SAXONY, SILESIA, &c.

Months.	Freiberg.		Dresden.		Altenberg.		Ober-Wiesenthal.		Zittau.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	27. 28	1. 58	29. 19	1. 48	23. 85	1. 59	26. 35	1. 92	25. 83	2. 05
February	31. 67	1. 15	33. 31	. 63	29. 48	. 60	30. 69	1. 24	30. 29	1. 27
March	38. 48	1. 68	39. 92	1. 47	33. 22	1. 67	33. 58	3. 08	32. 47	1. 51
April	43. 63	1. 68	46. 60	1. 31	43. 48	1. 58	41. 90	2. 39	45. 88	1. 67
May	52. 61	2. 73	58. 33	1. 75	54. 28	1. 88	51. 13	1. 86	53. 98	2. 15
June	62. 42	2. 88	65. 17	2. 75	58. 73	3. 87	57. 58	2. 92	61. 05	3. 06
July	65. 19	3. 61	67. 48	3. 12	61. 03	4. 70	58. 96	3. 17	62. 92	3. 17
August	63. 55	2. 14	65. 35	2 29	59. 74	4. 03	58. 87	3. 79	60. 91	2. 74
September	56. 35	2. 32	58. 26	2. 00	52. 84	3. 47	52. 75	2. 30	56. 53	1. 74
October	48. 42	1. 85	50. 05	1. 09	46. 15	1. 40	45. 12	1. 46	48. 29	1. 28
November	37. 67	1. 83	38. 84	1. 48	33. 55	2. 18	33. 76	2. 83	36. 01	1. 51
December	31. 08	1. 76	33. 69	1. 66	28. 96	2. 35	28. 62	3. 77	30. 51	2. 05

Months.	Gorlitz.		Landeskrone.		Sagan.		Zechen.		Zapplau.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	12. 69	1. 33	23. 73	. 91	25. 41	1. 04	27. 42	1. 28	31. 44	1. 10
February	21. 42	2. 14	27. 70	. 98	26. 71	1. 22	29. 57	1. 73	35. 38	. 87
March	36. 64	1. 36	35. 94	. 48	32. 83	1. 07	31. 69	1. 55	38. 75	1. 19
April	43. 07	1. 92	45. 07	. 84	45. 66	. 98	48. 23	1. 40	49. 44	1. 68
May	55. 15	2. 60	56. 05	2. 80	55. 24	1. 06	59. 23	1. 97	55. 06	2. 50
June	61. 21	3. 07	62. 69	5. 80	63. 43	1. 95	65. 48	3. 37	62. 94	3. 50
July	63. 21	2. 69	65. 73	3. 22	65. 98	2. 31	67. 75	2. 79	68. 00	2. 62
August	58. 33	3. 66	63. 25	3. 69	64. 85	1. 94	63. 93	2. 92	66. 88	2. 57
September	58. 28	2. 43	56. 01	. 97	57. 11	1. 22	58. 75	1. 41	62. 38	1. 44
October	45. 10	1. 75	47. 23	. 53	47. 82	1. 52	51. 83	1. 89	53. 38	1. 22
November	33. 60	2. 25	36. 91	2. 02	35. 26	1. 20	40. 37	2. 11	43. 25	1. 55
December	29. 59	1. 49	29. 93	1. 01	29. 55	1. 31	28. 83	1. 43	38. 46	1. 09

Months.	Breslau.		Neurode.		Proscau.		Neisse.		Leobschüg.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	27. 34	. 72	22. 12	1. 79	27. 06	. 72	27. 24	. 75	26. 69	1. 33
February	31. 89	. 57	27. 06	. 96	31. 08	1. 39	31. 87	. 52	31. 87	. 99
March	38. 35	. 74	31. 81	1. 41	34. 75	1. 39	36. 97	1. 17	39. 09	1. 67
April	45. 93	. 98	45. 48	2. 57	48. 68	1. 37	50. 48	2. 37	48. 47	1. 90
May	58. 98	1. 31	55. 74	2. 77	59. 46	1. 97	59. 48	1. 96	59. 07	2. 50
June	61. 70	2. 12	61. 43	4. 82	67. 37	3. 35	66. 25	3. 57	61. 66	3. 46
July	67. 75	1. 83	64. 05	4. 06	68. 74	3. 88	68. 46	2. 93	67. 56	3. 60
August	66. 97	1. 55	61. 97	3. 63	67. 30	5. 06	67. 58	2. 76	66. 97	2. 25
September	59. 97	1. 30	57. 27	1. 98	59. 88	1. 95	61. 03	2. 17	59. 72	2. 20
October	51. 10	. 96	48. 36	1. 82	53. 33	2. 03	52. 52	1. 59	51. 24	1. 93
November	40. 89	. 88	34. 77	2. 18	36 50	1. 70	42. 53	1. 45	41. 23	1. 50
December	31. 31	. 88	29. 64	2. 18	32. 16	. 94	32. 69	. 91	31. 31	1. 49

Months.	Ratisbon.		Kreuzburg.		Posen.		Warschau.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	24. 56	1. 04	27. 27	1. 67	27. 28	1. 40	.....	1. 12
February	29. 29	1. 34	29. 52	1. 04	29. 06	1. 31	.....	1. 03
March	32. 23	1. 35	38. 57	1. 70	31. 18	. 97	.....	1. 49
April	48. 68	1. 17	45. 91	1. 43	48. 32	1. 13	.....	1. 27
May	58. 80	2. 45	58. 94	2. 52	58. 35	1. 36	.....	1. 73
June	63. 86	3. 19	65. 59	3. 12	66. 72	2. 94	.....	2. 29
July	68. 20	3. 09	67. 84	3. 34	68. 65	2. 70	.....	3. 54
August	67. 65	3. 99	66. 52	3. 42	67. 62	2. 51	.....	2. 58
September	58. 37	2. 02	59. 50	2. 20	59. 03	1. 74	.....	1. 93
October	52. 35	1. 56	48. 22	2. 15	52. 19	1. 56	.....	2. 64
November	34. 02	1. 92	40. 89	1. 37	38. 55	1. 84	.....	1. 92
December	26. 81	1. 26	31. 84	1. 59	31. 84	1. 07	.....	1. 20

Table showing the monthly averages of temperature and rainfall, &c.—Continued.

BAVARIA.

Months.	Andex.		Peissenberg.		München.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	29.37	1.18	28.24	.28	29.75	.75
February	31.32	.66	30.78	.23	33.28	.68
March	38.03	1.03	33.85	.34	41.22	.40
April	48.04	.94	43.21	.50	50.43	1.36
May	58.96	.94	52.30	1.16	61.12	1.71
June	65.08	2.07	55.92	1.69	65.62	2.36
July	67.71	1.61	60.51	1.69	68.25	1.62
August	66.00	1.90	60.26	1.63	67.60	2.03
September	60.80	.60	53.56	1.17	61.12	1.11
October	48.92	.62	44.51	.73	52.78	1.59
November	37.18	.64	35.89	.47	42.53	.89
December	29.73	.66	31.12	.32	38.53	.40

Months.	Augsburg.		Regensburg.		Wurzburg.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	25.95	1.12	26.87	.61	32.50	.66
February	30.76	.99	31.66	.54	34.68	.71
March	38.14	1.08	38.12	.56	41.54	.69
April	48.02	.83	49.55	.60	52.25	.51
May	56.62	2.07	59.11	.95	61.07	.59
June	61.21	1.88	62.67	1.20	66.81	.74
July	64.63	2.33	65.95	1.35	68.29	.56
August	63.43	1.87	64.36	1.33	67.08	.56
September	57.22	1.60	58.01	.95	61.23	.58
October	47.12	1.11	47.91	.72	51.01	.42
November	37.40	1.35	37.06	.76	39.47	.82
December	31.57	1.04	29.66	.78	33.51	.41

RHEINTHAL.

Months.	Goersdorf.		Strassburg.		Hagenau.		Karlsruhe.		Heidelberg.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	.....	2.75	.....	1.38	.....	2.24	.....	1.88	31.62	1.68
February	.....	3.64	.....	1.51	.....	1.42	.....	1.81	36.43	1.57
March	.....	3.20	.....	1.66	.....	1.77	.....	1.98	43.77	2.00
April	.....	3.64	.....	1.58	.....	1.86	.....	1.86	53.04	1.56
May	.....	2.66	.....	3.02	.....	2.00	.....	2.48	61.03	2.73
June	.....	2.57	.....	3.09	.....	2.89	.....	2.56	65.53	3.02
July	.....	3.90	.....	3.32	.....	1.18	.....	3.08	68.70	2.68
August	.....	3.90	.....	2.62	.....	3.39	.....	2.67	66.88	2.62
September	.....	2.93	.....	2.71	.....	3.19	.....	2.42	60.67	2.31
October	.....	2.93	.....	1.96	.....	1.91	.....	2.08	51.42	2.15
November	.....	2.75	.....	2.21	.....	3.49	.....	2.60	41.68	2.62
December	.....	2.75	.....	1.57	.....	1.24	.....	2.48	36.70	2.17

Months.	Manheim.		Gussen.		Salzhausen.		Neunkirchen.		Kreuznach.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	33.33	1.28	30.16	1.89	31.06	.98	31.32	2.42	32.92	1.54
February	35.60	1.27	31.86	1.40	31.87	1.06	32.13	.79	39.52	.96
March	40.15	1.40	38.69	1.16	40.89	.30	41.07	1.36	43.59	1.03
April	50.70	1.90	46.02	1.81	49.37	.68	50.30	2.14	52.05	1.52
May	59.50	2.10	57.18	3.70	58.67	2.50	57.14	3.46	59.20	2.43
June	67.21	2.51	64.63	3.44	66.04	4.28	65.42	3.27	67.30	2.87
July	68.81	3.20	63.93	3.67	67.82	3.47	67.39	2.92	68.89	2.46
August	66.27	2.73	64.02	3.29	66.45	4.69	66.47	2.71	68.72	2.38
September	61.77	2.13	58.82	1.19	59.61	.43	59.27	1.76	61.45	1.46
October	49.35	1.76	53.55	3.56	50.16	1.93	52.30	2.55	53.99	1.47
November	38.75	1.53	38.89	1.65	38.93	1.07	38.78	1.91	42.24	1.68
December	31.91	1.25	31.85	2.13	33.57	2.75	32.23	1.22	37.67	1.10

Table showing the monthly averages of temperature and rainfall, &c.—Continued.

RHEINTHAL.

Months.	Frankfurt.		Boppard.		Coblenz.		Bonn.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	31.46	.79	32.72	1.71	32.20	2.76	32.94	1.80
February	36.68	.48	39.75	1.64	39.81	.72	40.49	1.62
March	41.54	.67	42.67	1.62	43.63	1.68	40.98	1.71
April	49.10	1.30	50.58	2.79	52.72	1.56	51.62	1.99
May	57.74	2.46	57.88	2.42	62.94	2.06	58.60	1.48
June	63.50	2.79	66.04	2.73	68.63	2.48	66.59	1.50
July	66.07	2.63	67.84	2.64	68.00	2.61	68.70	2.71
August	65.73	1.46	63.71	3.18	69.40	2.66	68.82	3.45
September	59.41	.93	57.18	1.98	63.68	2.37	61.93	2.11
October	49.24	.95	54.03	2.17	55.36	1.31	55.22	2.43
November	40.96	.98	43.26	1.86	46.56	1.81	43.75	1.88
December	34.25	1.06	39.09	2.15	39.04	1.68	39.04	1.83

Months.	Frier.		Cöln.		Crefeld.		Cleve.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	32.61	1.71	34.77	1.56	32.54	1.96	32.20	2.65
February	40.89	1.79	40.60	1.50	39.18	2.27	39.43	2.29
March	44.04	1.72	43.57	1.24	42.17	1.27	42.13	1.55
April	53.31	1.36	51.98	2.44	50.84	2.76	49.42	2.29
May	61.95	2.26	59.59	2.73	58.80	2.21	57.36	2.84
June	66.27	2.23	66.75	2.84	66.45	2.48	64.43	2.90
July	69.40	2.55	69.55	2.42	68.84	2.48	66.90	2.87
August	66.09	2.68	68.52	2.73	67.42	3.27	66.21	3.30
September	61.95	2.28	62.49	1.68	61.07	1.43	60.53	1.97
October	54.07	2.08	55.22	2.24	53.78	2.70	53.38	3.02
November	44.13	2.30	44.09	2.80	42.50	2.24	42.83	2.37
December	38.40	2.30	34.46	1.74	39.27	2.56	39.59	2.83

Months.	Aachen.		Elberfeld.		Düsseldorf.		Mühlhausen.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	32.78	2.09	33.50	1.76	35.06	1.97	14.02	2.63
February	49.90	2.63	40.44	1.84	39.09	1.33	21.22	1.99
March	43.26	2.75	43.23	1.71	44.24	2.71	36.97	2.02
April	51.15	2.76	51.74	2.04	52.16	1.06	40.75	2.36
May	59.03	1.89	56.93	2.36	60.24	1.93	51.06	2.74
June	65.48	1.11	62.35	2.54	64.65	2.74	60.42	3.19
July	66.45	2.65	65.37	2.15	66.54	2.34	61.05	2.50
August	66.30	3.87	63.68	2.11	65.66	2.48	64.54	2.50
September	61.10	2.32	59.52	2.32	60.42	2.70	53.96	2.84
October	53.20	2.14	53.42	3.35	52.00	1.70	48.72	2.77
November	46.27	2.30	45.98	1.84	44.04	1.54	39.85	2.48
December	39.54	3.34	41.05	2.39	37.04	2.09	34.57	2.11

THURINGIA, ETC.

Months.	Ziegenrück.		Arnstadt.		Jena.		Erfurt.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	33.14	.95	30.36	1.31	32.00	1.37	29.39	.72
February	31.08	1.49	30.22	.93	35.35	1.09	33.55	1.20
March	38.53	1.12	39.02	1.19	38.53	1.49	37.74	1.17
April	47.08	2.11	49.57	1.54	50.70	1.80	47.68	2.38
May	55.02	2.98	57.49	2.41	59.28	2.52	57.79	2.51
June	63.57	3.55	63.12	2.57	64.40	2.77	64.06	2.77
July	64.52	3.28	67.03	2.47	66.94	2.87	67.03	2.60
August	64.29	3.73	65.53	1.31	63.57	2.53	65.48	1.86
September	56.25	2.30	58.33	1.72	58.57	2.01	60.69	1.64
October	50.52	1.53	49.75	1.33	49.87	1.67	47.39	2.11
November	38.59	1.39	38.30	1.40	41.45	1.57	38.95	1.23
December	31.37	1.19	34.18	1.17	33.55	1.27	30.45	.86

Table showing the monthly averages of temperature and rainfall, &c.—Continued.

THURINGIA, ETC.

Months.	Gotha.		Mühlhausen.		Heiligenstadt.		Ballinstedt.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	24.73	1.20	14.02	.79	30.00	1.30	31.87	2.20
February	31.26	1.68	21.22	1.20	32.19	1.66	32.16	2.52
March	38.91	1.24	36.97	1.02	39.70	1.51	39.75	1.73
April	48.22	2.18	40.75	1.69	48.76	2.39	50.03	3.19
May	58.24	2.11	51.06	1.95	56.08	2.35	58.84	3.87
June	64.83	2.99	60.42	2.66	63.73	2.95	64.00	5.90
July	69 82	3.32	61.05	1.85	70.48	3.11	68.41	4.32
August	65.98	3.39	64.54	1.95	66.66	3.55	68.16	2.98
September	59.16	2.12	53.96	1.18	57.83	2.33	60.81	2.71
October	50.65	2.66	48.72	1.43	51.96	2.94	50.41	2.69
November	37.51	1.34	39.85	.96	39.52	1.71	40.37	3.38
December	31.17	1.34	34.57	1.53	32.11	1.58	32.23	2.60

Months.	Brocken.		Braunschweig.		Clausthal.		Göttingen.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	9.03	2.60	31.20	1.70	30.49.	3.74	33.51	1.28
February	17.49	4.23	32.46	2.29	31.89	3.45	40.87	1.74
March	26.49	2.88	39.13	2.68	31.12	3.37	50.99	1.56
April	28.42	2.33	48.20	2.16	43.37	3.45	64.29	1.86
May	41.27	3.67	60 13	1.68	52.28	3.66	72.32	1.44
June	47.53	5.50	66.85	1.99	59.32	4.90	75.54	2.57
July	50.29	7.41	69.22	2.84	62.78	7.62	73.49	3.28
August	45.07	6.62	67.91	2.34	64.00	6.70	65.82	3.64
September	46.76	5.24	61.57	1.36	55.50	2.02	53.02	2.89
October	37.92	5.63	53.87	2.35	50.84	3.95	40.12	2.05
November	27.59	3.86	43.59	1.59	38.05	7.24	35.47	2.20
December	24.93	3.54	38.69	1.57	32.79	8.45	32.46	1.85

Months.	Hannover.		Hildesheim.		Bremen.		Oldenberg.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	31.89	1.13	32.00	1.11	29.58	1.80	31.54	1.42
February	38.80	.86	31.89	1.98	34.12	1.53	32.16	.25
March	40.94	.97	40.94	.22	39.14	2.18	38.40	1.54
April	48.77	3.28	43.68	2.35	46.27	1.33	46.05	1.44
May	57.59	2.44	56.03	3 04	55.93	1.62	55.90	.....
June	66.70	3.65	66.18	2.29	61.94	2.24	63.80	.....
July	67.53	4.61	66.52	2.84	64.62	2.97	64.56	.....
August	66.88	2.34	66.72	2.20	63.33	2.10	63.55	.....
September	60.62	.92	60.25	.19	57.70	1.88	57.70	.....
October	53.20	1.74	54.32	1.70	50.13	2.09	46.27	.50
November	41.01	2.17	38.62	1.79	30.13	2.01	89.47	3.65
December	38.48	3.09	39.25	1.12	35.61	2.36	32.13	2.85

Months.	Jever.		Torgau.		Halle.		Salzwedel.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	31.82	2.07	30.05	1.17	26.89	.84	31.84	1.46
February	33.10	.33	32.30	1.94	31.32	1.32	32.18	1.86
March	38 41	1.97	39.77	1.15	39.65	.91	36.93	1.29
April	44.80	2.19	49.37	1.91	47.17	1.33	48.61	1.49
May	54.57	.....	58.60	2.99	55.69	2.74	57.40	1.98
June	56.12	.....	66.68	3.30	61.32	3.93	65.28	3.24
July	64.24	.....	69.13	2.49	66.61	2.66	67.42	2.44
August	63.66	.....	67.67	1.47	62.85	1.55	66.42	2.46
September	58.78	2.83	60.19	1.80	58.57	1.74	59.29	2.00
October	49.93	.44	53.35	1.71	48.40	1.20	52.50	2.18
November	39.79	4.17	36.91	2.03	37.55	1.18	39.85	1.80
December	36.48	2.79	32.18	1.54	36.30	1.05	32.16	1.21

Table showing the monthly averages of temperature and rainfall, &c.—Continued.

THURINGIA, ETC.

Months.	Lüneburg.		Altona.		Hamburg.		Otterndorf.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	31.26	1.29	34.23	1.32	30.00	.....	31.87	1.99
February	35.31	.92	37.90	.....	34.41	.....	37.67	1.20
March	39.85	.82	41.25	.....	38.05	.91	39.97	1.03
April	47.62	1.48	52.27	.....	46.72	1.25	47.08	1.52
May	55.92	2.79	60.31	.....	56.84	1.67	52.59	3.59
June	61.88	3.07	67.42	.....	62.15	2.11	63.10	2.19
July	64.38	3.59	70.34	.....	64.63	2.30	65.08	2.90
August	62.87	3.03	70.43	.....	64.38	3.28	65.95	5.61
September	57.07	2.29	63.18	1.50	57.18	1.36	60.10	1.45
October	47.39	2.15	53.51	1.32	48.07	2.96	52.75	2.54
November	41.14	1.62	42.91	2.93	40.24	4.78	40.82	2.94
December	34.57	2.19	39.29	2.94	33.76	.....	37.67	1.71

Months.	Frankfort-am-Oder.		Berlin.		Potsdam.		Pessin.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	31.46	1.20	27.20	1.34	32.95	.91	.....	2.15
February	36.68	1.44	31.66	1.37	32.46	1.31	.....	1.15
March	41.54	1.23	38.17	1.25	40.35	.81	.....	1.52
April	49.10	1.68	47.48	1.30	49.96	1.41	.....	1.28
May	57.74	2.18	56.57	1.97	55.50	1.88	.....	1.90
June	63.50	3.00	63.37	2.77	66.72	2.00	.....	2.19
July	66.07	2.72	65.84	2.54	68.65	1.16	.....	2.35
August	65.73	7.48	64.47	1.92	67.74	2.05	.....	1.89
September	59.41	1.39	58.44	1.81	59.70	1.19	.....	1.71
October	49.24	1.30	49.93	1.38	51.02	1.32	.....	1.21
November	40.96	1.87	39.31	1.42	41.29	1.22	.....	2.13
December	34.25	1.39	34.97	1.71	32.19	.87	.....	2.00

Months.	Wittslock.		Prenzlau.		Lubbenow.		Schwedt.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	.....	1.45	33.95	.56	.....	.82	.....	.71
February	.....	1.10	35.76	.58	.....	.97	.....	.17
March	.....	.64	38.34	.16	.....	.33	.....	.31
April	.....	1.89	45.40	1.13	.....	1.44	.....	2.30
May	.....	1.73	57.58	1.58	.....	1.76	.....	2.27
June	.....	2.32	63.54	2.92	.....	2.17	.....	5.16
July	.....	1.68	66.31	1.50	.....	2.79	.....	2.00
August	.....	4.74	65.14	4.00	.....	4.69	.....	2.65
September	.....	1.45	58.77	.69	.....	1.05	.....	1.32
October	.....	.50	49.28	.32	.....	.64	.....	.....
November	.....	2.07	37.40	.74	.....	.80	.....	.....
December	.....	1.03	36.70	.63	.....	.87	.....	1.12

Months.	Boitzenburg.		Hagenow.		Schwerin.		Poel.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	.....	1.15	.....	1.59	31.58	1.67	31.17	1.04
February	.....	1.50	.....	1.33	32.17	1.33	32.69	.69
March	.....	.47	.....	1.06	39.90	1.54	39.49	.63
April	.....	1.94	.....	.96	47.80	1.53	46.90	1.03
May	.....	2.07	.....	4.16	57.32	1.92	55.63	1.32
June	.....	2.57	.....	1.95	65.42	2.29	62.65	1.59
July	.....	2.75	.....	5.98	67.58	2.84	65.95	2.64
August	.....	4.45	.....	2.78	66.92	2.90	66.18	2.42
September	.....	1.55	.....	1.33	59.79	1.85	60.13	1.79
October	.....	.59	.....	1.78	52.82	1.64	52.77	1.11
November	.....	1.74	.....	1.83	40.78	1.47	41.01	1.01
December	.....	1.38	.....	2.23	32.46	1.92	32.36	1.19

Table showing the monthly averages of temperature and rainfall, &c.—Continued.

THURINGIA, ETC.

Months.	Lübeck.		Schönberg.		Eutin.		Neustadt.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	29.52	.93	23.00	1.71	31.34	1.96	27.70	1.47
February	31.87	.97	30.13	1.32	31.87	.53	30.29	.....
March	39.27	1.00	29.93	1.54	39.27	1.76	39.61	.....
April	48.83	1.16	43.59	1.64	48.45	1.49	49.80	.....
May	56.73	1.49	50.36	2.25	56.71	.....	56.12	.....
June	63.46	2.46	61.82	2.60	64.47	.....	60.76	.....
July	66.09	2.66	63.98	3.48	66.59	.....	64.92	.....
August	66.32	2.38	63.60	2.56	66.27	4.92	64.38	.....
September	59.50	1.90	56.35	1.41	59.72	1.96	58.64	2.26
October	51.83	2.61	48.97	1.84	51.40	1.87	48.52	.60
November	42.00	1.43	32.23	1.25	39.66	2.46	37.40	2.25
December	32.70	1.00	32.25	1.77	32.96	2.87	34.39	2.63

Months.	Neumünster.		Keil.		Goldberg.		Rostock.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	31.89	2.02	31.10	2.11	31.69	.85	30.20	1.37
February	32.70	.....	34.70	1.54	31.85	.75	32.90	1.00
March	39.21	.....	36.84	1.19	38.46	.56	40.26	.65
April	47.55	.....	48.70	1.27	47.64	1.48	47.69	1.65
May	56.10	.....	55.67	1.89	57.77	1.75	57.00	1.63
June	63.32	.....	63.91	2.47	65.76	1.99	64.67	1.30
July	66.02	.....	66.16	2.04	67.33	3.43	67.60	2.71
August	65.08	.....	66.16	2.47	66.97	2.95	67.33	2.85
September	58.44	2.25	59.91	1.89	60.24	1.57	60.64	2.31
October	50.91	.36	53.13	1.91	52.99	1,52	52.65	1.85
November	38.57	3.19	41.16	1.62	38.14	.94	40.82	1.06
December	32.11	2.77	34.68	2.05	32.70	2.37	34.75	1.68

Months.	Sülz.		Wustrow.		Stralsund.		Putbus.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	29.60	1.40	28.80	1.10	26.24	1.56	29.37	1.35
February	32.62	.24	31.77	.47	29.48	1.02	31.89	.72
March	39.72	1.21	38.53	.37	35.44	1.18	38.87	.92
April	47.87	2.29	45.51	1.32	45.40	1.84	46.16	1.26
May	56.64	.....	54.75	1.33	54.61	1.31	55.22	1.47
June	63.28	.....	63.15	1.94	61.88	2.39	63.98	3.04
July	65.78	2.43	66.45	1.76	63.93	1.73	66.75	2.68
August	65.12	4.24	63.68	1.88	62.37	2.12	66.65	3.60
September	59.39	2.87	60.51	1.56	57.33	2.65	59.86	1.99
October	51.69	1.29	53.16	1.17	50.77	2.80	52.43	1.46
November	39.13	1.57	41.52	.74	38.70	2.34	40.89	1.27
December	32.96	1.67	33.41	.87	34.21	2.49	34.24	3.09

Months.	Stettin.		Hinrichshagen.		Colberg.		Coslin.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	29.34	1.08	31.12	1.15	29.12	1.46	28.22	1.38
February	32.11	1.23	31.31	1.42	31.80	1.04	31.82	1.22
March	38.57	.93	33.57	1.05	34.75	1.03	32.11	.97
April	42.96	1.44	45.77	1.58	46.22	1.35	45.62	1.28
May	58.82	1.84	55.20	1.86	50.95	2.37	51.78	2.09
June	63.79	2.68	63.34	2.20	62.78	5.83	63.46	3.14
July	66.34	1.99	65.35	2.47	66.38	2.70	66.09	2.30
August	64.24	3.08	65.10	2.96	65.91	2.87	65.46	3.00
September	60.15	1.42	54.93	1.76	59.25	2.31	58.65	2.62
October	49.30	1.45	51.08	1.98	52.28	2.46	51.55	2.62
November	40.24	1.62	38.64	1.90	40.89	1.79	39.45	2.72
December	35.29	1.27	31.87	.99	32.54	1.53	31.54	1.65

Table showing the monthly averages of temperature and rainfall, &c.—Continued.

FRANCE.

Months.	Vendome.			Versailles.			Rouen.		
	Temp.	Rain-fall.	Rainy days.	Temp.	Rain-fall.	Rainy days.	Temp.	Rain-fall.	Rainy days.
January		1.78		34.48	1.74		30.42	2.79	
February		.66		38.98	1.17		35.83	2.62	
March		1.95		37.85	1.61		44.38	2.78	
April		1.92		51.80	2.48		50.68	3.24	
May		3.09		59.45	1.91		59.90	1.96	
June		1.47		69.35	1.46		63.50	2.31	
July		2.18		65.75	2.72		66.20	2.12	
August		1.85		65.75	2.20		65.75	3.62	
September		1.76		57.88	1.57		61.70	2.66	
October		1.81		46.40	2.36		52.25	3.13	
November		1.81		36.50	1.62		41.90	2.48	
December		1.34		38.08	1.46		36.05	3.20	

Months.	Chalons-sur-Marne.			Lons-le-Saulnier.			Pontarlier.		
	Temp.	Rain-fall.	Rainy days.	Temp.	Rain-fall.	Rainy days.	Temp.	Rain-fall.	Rainy days.
January		1.31	7		2.49	10		2.78	10
February		.70	8		3.20	12		1.75	12
March		1.16	11		2.66	14		2.20	11
April		1.07	10		2.99	11		3.55	12
May		1.40	10		3.02	9		3.73	10
June		2.55	10		6.29	10		4.69	15
July		1.28	8		3.33	10		4.97	11
August		.88	6		2.68	11		3.90	10
September		1.96	8		3.92	9		4.13	9
October		.84	7		3.04	9		3.60	10
November		1.49	13		2.93	12		3.65	12
December		1.16	8		3.53	13		4.79	13

Months.	Berzé-la-Ville.			Le Puy.			Paris.		
	Temp.	Rain-fall.	Rainy days.	Temp.	Rain-fall.	Rainy days.	Temp.	Rain-fall.	Rainy days.
January		1.87		38.75	1.25	4	35.44	1.49	11.8
February		2.12		41.63	1.30	4	39.54	1.61	12.9
March		2.11		51.33	2.02	4	43.99	1.08	13.0
April		2.57		55.27	3.66	9	49.78	2.09	12.8
May		3.46		64.72	1.25	9	58.08	2.86	13.8
June		2.95		71.49	5.01	11	62.74	2.41	24.9
July		2.95		71.20	2.49	3	65.66	2.32	14.3
August		3.51		74.71	2.30	6	65.35	2.02	10.5
September		2.88		66.27	3.74	8	66.17	1.98	11.9
October		2.88		56.35	4.13	6	52.25	1.45	12.7
November		3.40		51.24	1.56	4	44.17	1.84	13.9
December		2.47		39.67	2.67	13	38.57	1.47	14.7

Months.	Denainvilliers.			Montmorency.			Lille.		
	Temp.	Rain-fall.	Rainy days.	Temp.	Rain-fall.	Rainy days.	Temp.	Rain-fall.	Rainy days.
January	34.93	1.18	10	34.25	1.02	13		2.27	
February	39.65	1.06	10	38.98	.58	14		1.69	
March	41.90	1.47	10	44.60	1.43	11		1.99	
April	50.90	1.48	11	49.33	2.69	12		1.74	
May	59.23	1.51	10	57.88	1.92	13		1.43	
June	66.88	2.51	10	63.50	4.26	14		3.66	
July	69.35	1.81	9	66.88	1.88	13		3.20	
August	67.55	1.68	9	68.00	2.82	10		3.74	
September	61.48	1.99	7	61.70	1.79	11		3.44	
October	51.80	1.30	8	52.93	2.97	13		2.27	
November	42.13	1.59	10	43.48	2.00	12		2.55	
December	37.40	1.33	11	40.10	2.74	11		1.68	

Table showing the monthly averages of temperature and rainfall, &c.—Continued.

FRANCE.

Months.	Bergues St. Vissoox.			Cambrai.			Maestricht.		
	Temp.	Rainfall.	Rainy days.	Temp.	Rainfall.	Rainy days.	Temp.	Rainfall.	Rainy days.
January		1.94		38.75	.90			1.84	
February		1.69		40.33	.70			1.98	
March		1.96		44.83	1.18			2.38	
April		1.14		52.70	1.81			1.21	
May		1.58		60.35	1.37			2.57	
June		2.12		68.00	1.77			2.69	
July		2.19		68.23	2.40			2.90	
August		2.49		67.55	1.71			2.22	
September		2.21		62.60	1.71			1.95	
October		2.37		50.90	1.88			1.17	
November		2.12		40.33	1.68			1.87	
December		3.52		38.75	.83			2.01	

Months.	Laon.			Montdidier.			Troyes.		
	Temp.	Rainfall.	Rainy days.	Temp.	Rainfall.	Rainy days.	Temp.	Rainfall.	Rainy days.
January		2.05	14		1.96	11	34.48	1.79	9
February		2.10	15		1.41	11	36.95	.98	9
March		1.96	18		1.86	12	46.85	1.19	9
April		1.77	12		1.73	1	52.48	2.12	11
May		1.77	12		1.60	8	58.55	3.21	12
June		2.90	13		1.49	12	66.20	2.35	10
July		2.47	15		2.58	14	69.35	2.15	10
August		2.62	14		2.48	11	68.73	2.20	10
September		2.29	14		2.32	11	62.60	1.81	9
October		2.42	12		2.87	11	52.70	1.02	8
November		1.90	12		1.73	9	42.35	3.27	13
December		2.02	13		1.86	12	43.25	1.67	10

Months.	Nancy.			La Chappelle.			Cherbourg.		
	Temp.	Rainfall.	Rainy days.	Temp.	Rainfall.	Rainy days.	Temp.	Rainfall.	Rainy days.
January	31.32	2.56	13	37.54	2.73			4.09	
February	38.75	2.88	12	38.39	2.31			2.27	
March	45.50	2.70	11	43.66	1.90			4.03	
April	51.80	3.40	10	48.70	1.92			3.15	
May	58.33	2.59	13	53.20	2.67			2.11	
June	64.85	2.88	12	58.91	2.75			2.11	
July	69.35	3.29	14	60.85	2.90			1.93	
August	69.13	3.27	8	62.29	2.79			3.77	
September	61.03	2.60	10	58.69	3.36			2.17	
October	52.93	3.32	14	51.85	3.70			5.20	
November	43.25	3.41	15	48.16	3.11			5.34	
December	36.95	2.03	13	38.98	2.15			3.51	

Months.	St. Lo.			Besançon.		
	Temp.	Rainfall.	Rainy days.	Temp.	Rainfall.	Rainy days.
January		3.42		34.70	3.05	10
February		2.73		36.95	2.98	16
March		2.18		43.93	3.46	12
April		2.14		53.18	5.61	11
May		2.18		66.65	3.32	12
June		2.34		68.68	3.41	13
July		2.59		70.25	3.80	13
August		2.14		66.88	4.48	12
September		3.45		61.25	2.70	10
October		3.54		47.98	5.19	11
November		2.12		38.75	3.48	16
December		2.41		36.73	2.83	14

Table showing the monthly averages of temperature and rainfall, &c.—Continued.

FRANCE.

Months.	Ft. Breville.			Grenoble.		
	Temp.	Rainfall.	Rainy days.	Temp.	Rainfall.	Rainy days.
January		1.09			.98	9.5
February		.79			4.09	14.0
March		1.44			2.33	16.0
April		2.69			3.83	17.4
May		2.20			1.58	16.8
June		2.48			2.59	16.8
July		2.59			1.63	13.6
August		3.22			2.73	12.6
September		1.75			2.20	15.0
October		3.67			4.83	9.0
November		1.75			3.55	15.0
December		.54			5.82	17.0

We see, in looking over these tables, that nowhere where the industry is most prosperous do we find that the average monthly temperature during the summer months exceeds the maximum above spoken of, 70° F.; nor does the average monthly rainfall appear lower than a minimum of 2 inches during the same season. Taking the maximum average temperature as here determined, 70° F., for the summer months as a guide, at the same time keeping in view the average of 2 inches for rainfall, I have collected in the following tables the averages of temperature and rainfall for all the stations in the United States for which the records for temperature for June, July, or August are below that figure, and have caused the accompanying maps to be constructed, showing by the red line the limits of the sections in which these stations are located. The figures are taken from Schott's Temperature and Rain Tables, prepared under the direction of the Smithsonian Institution.

TABLES SHOWING THE MONTHLY AVERAGES OF TEMPERATURE AND RAINFALL FOR THOSE STATIONS IN THE UNITED STATES AT WHICH THE MAXIMUM AVERAGE OF TEMPERATURE IS BELOW 70° F. AND THE MINIMUM AVERAGE OF RAINFALL ABOVE 2 INCHES DURING THE SUMMER MONTHS.

MAINE.

Months.	Augusta.		Bath.		Belfast.		Bethel.		Brunswick.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	19.87		23.22	4.31	15.58		14.10	3.51	20.10	3.24
February	27.00		23.32	3.37	20.49		18.68	3.47	22.93	2.75
March	32.20		31.65	2.88	28.74		26.63	3.77	31.54	3.72
April	38.67		41.86	2.89	41.25		38.40	4.93	42.56	3.44
May	50.30		52.37	3.59	54.21		49.02	3.91	52.69	4.55
June	65.61		61.32	2.55	62.88		61.80	2.62	62.29	3.69
July	68.65		68.71	2.31	68.34		67.27	6.12	67.44	3.65
August	65.86		66.06	3.07	65.70		63.97	1.56	65.60	4.37
September	60.39		59.23	1.77	58.43		56.57	3.19	58.28	3.03
October	50.50		47.74	3.35	46.38		47.12	5.08	47.78	3.74
November	42.55		35.90	3.27	36.08		33.23		36.71	4.65
December	21.58		25.10	3.72	19.95		22.68	2.01	24.86	3.85

Table showing the monthly averages of temperature and rainfall, &c.—Continued.

MAINE.

Months.	Castine.		Cornish.		Dennysville.		Dexter.		Eastport.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	21.41	.....	18.47	3.70	19.13	.....	14.53	3.24	20.00	2.64
February	22.30	....	21.16	3.86	20.06	.....	21.15	2.94	22.70	.95
March	30.38	.....	28.32	4.41	29.06	.....	27.21	4.69	28.80	2.25
April	41.43	.....	40.58	4.07	39.66	.....	39.34	2.91	39.50	3.15
May	50.53	.....	52.53	3.36	50.42	.....	52.51	2.88	48.20	4.50
June	59.43	.....	63.51	3.60	59.84	.....	62.12	3.31	55.50	4.00
July	64.82	.....	68.56	4.21	65.67	.....	66.99	3.75	63.80	2.70
August	64.66	.....	66.05	4.67	63.87	.....	66.76	1.60	63.70	5.82
September	58.39	....	58.20	2.99	56.67	....	58.74	2.78	56.20	2.20
October	48.44	.....	45.92	2.46	46.69	.....	46.25	3.32	46.10	6.20
November	38.06	.....	34.53	4.91	35.76	.....	34.94	4.31	35.70	3.15
December	25.57	.....	21.77	3.61	23.26	.....	21.21	2.99	24.50	2.52

Months.	Fort Fairfield.		Fort Kent.		Fort Preble.		Fort Sullivan.		Gardiner.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	15.60	.....	10.76	3.75	22.54	3.37	22.06	3.17	17.94	3.53
February	13.10	.....	11.26	2.60	24.61	3.39	23.23	3.19	20.72	2.86
March	24.40	.....	23.26	1.77	32.62	2.92	30.57	3.16	29.49	3.58
April	35.90	.....	35.08	1.06	43.22	4.14	40.11	2.79	41.24	3.41
May	47.70	.....	46.78	2.63	52.84	5.05	48.67	2.92	52.69	3.88
June	57.05	.....	59.00	1.36	63.31	3.39	56.24	2.15	63.06	3.39
July	62.83	.....	62.51	7.72	68.57	2.78	61.99	4.29	68.64	3.19
August	64.70	...	63.45	2.57	66.64	4.11	62.23	3.62	66.47	3.88
September	49.13	.....	51.18	1.36	56.66	3.31	57.14	3.17	58.07	2.90
October	39.92	.....	39.58	4.41	49.14	4.25	47.73	3.30	46.58	3.86
November	29.15	....	27.52	3.86	38.01	4.37	37.27	3.39	35.31	3.73
December	12.53	.....	10.86	3.36	26.88	4.06	25.56	4.26	22.14	3.88

Months.	Hampden.		Hancock's Barracks (Houlton).		Hiram.		Kennebec Arsenal.		Lee.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	8.88	.....	14.87	.....	17.01	.....	22.95	3.55	13.08	3.22
February	21.00	.....	16.68	.....	18.39	.....	15.51	2.25	21.62	5.09
March	29.64	.....	27.09	.....	28.23	.....	28.40	1.23	27.71	6.76
April	43.78	.....	39.43	.....	39.26	.....	40.74	5.33	41.85	3.72
May	51.88	.....	51.18	.....	51.45	.....	52.24	2.82	50.20	6.60
June	62.29	.....	61.15	.....	61.33	.....	64.59	2.79	64.14	1.42
July	63.21	.....	66.09	.....	67.17	.....	69.47	2.91	66.92	2.39
August	67.67	.....	64.73	.....	64.11	.....	65.49	5.10	65.34	2.00
September	56.75	.....	56.16	.....	56.29	.....	58.91	1.09	56.23	3.58
October	44.12	.....	43.71	.....	44.54	.....	47.02	3.14	45.16	3.92
November	30.30	.....	30.99	.....	33.17	.....	37.25	.30	35.69	4.17
December	21.64	.....	18.60	.....	20.91	.....	25.98	4.30	22.45	3.43

Months.	Lisbon.		North Brighton.		Oldtown.		Oxford.		Perry.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	18.46	2.75	14.05	.....	16.24	.....	19.06	.....	19.76	3.86
February	22.67	3.43	22.83	.....	17.17	.....	18.15	.....	23.17	3.41
March	29.23	4.69	28.00	.....	25.07	.....	28.48	.....	28.82	4.34
April	41.55	3.64	38.55	.....	37.38	.....	40.35	.....	38.89	3.81
May	54.08	3.70	51.62	.....	48.97	.....	52.54	.....	49.11	5.03
June	63.53	3.54	61.85	.....	58.75	.....	64.44	.....	57.59	3.89
July	68.92	3.28	70.57	.....	66.79	.....	68.94	.....	63.29	3.68
August	67.24	3.56	65.65	.....	63.88	.....	65.87	.....	61.55	3.44
September	58.21	3.83	58.17	.....	55.49	....	56.71	.....	55.67	3.20
October	47.62	4.77	47.77	.....	45.07	.....	44.63	.....	46.21	5.73
November	37.63	5.45	34.25	.....	32.49	.....	33.81	.....	35.62	6.31
December	22.66	3.36	23.05	.....	18.32	.....	20.72	.....	24.11	3.59

Table showing the monthly averages of temperature and rainfall, &c.—Continued.

MAINE.

Months.	Portland.*		Saco.		South Thomaston.		Standish.		Steuben.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	19.26	5.04	21.08	3.69	22.96	.....	19.89	1.48	19.10	4.35
February	21.46	2.05	21.29	3.26	24.96	.....	22.18	5.04	21.34	4.63
March	29.72	4.82	31.21	3.72	29.49	.....	27.71	5.70	28.52	4.76
April	40.05	4.34	43.69	2.12	39.12	.....	41.51	2.66	38.66	4.56
May	50.58	3.51	54.28	5.52	50.90	.....	52.84	4.11	48.74	5.50
June	60.27	3.16	65.06	2.69	63.37	.....	65.18	3.42	58.57	3.56
July	66.30	5.14	70.31	3.57	66.74	.....	69.97	2.79	63.73	3.76
August	64.68	4.67	68.44	4.76	63.84	.....	67.33	2.01	62.30	3.51
September	57.45	3.44	60.92	2.76	56.51	.....	59.49	1.26	55.65	3.79
October	45.39	4.58	47.18	4.34	48.63	.....	44.74	4.63	45.42	4.56
November	34.41	2.80	37.18	3.81	37.05	.....	35.24	3.74	35.81	4.96
December	23.85	5.08	25.34	4.87	21.03	.....	22.28	2.58	22.75	5.33

Months.	Vassalborough.		West Waterville.		Williamsburg.		Windham.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rain. fall.	Temp.	Rainfall.
January	17.84	.....	18.18	.....	13.94	.....	16.43	.....
February	19.01	.....	21.89	.....	16.68	.....	20.70	.....
March	29.35	.....	29.77	.....	24.33	.....	30.86	.....
April	40.57	.....	42.10	.....	38.29	.....	38.52	.....
May	54.06	.....	53.20	.....	50.33	.....	57.89	.....
June	62.18	.....	65.10	.....	61.55	.....	64.01	.....
July	64.92	.....	69.91	.....	66.93	.....	68.93	.....
August	66.64	.....	67.09	.....	63.59	.....	67.28	.....
September	56.28	.....	59.20	.....	50.57	.....	59.14	.....
October	46.53	.....	46.15	.....	45.05	.....	47.45	.....
November	36.83	.....	35.14	.....	32.72	.....	34.56	.....
December	21.10	.....	22.78	.....	17.80	.....	25.63	.....

NEW HAMPSHIRE.

Months.	Claremont.		Concord.		Dover.		Dublin.		Exeter.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	18.35	2.96	20.84	2.92	24.00	.....	18.52	.....	19.89	.....
February	22.47	3.26	22.73	3.34	23.60	.....	21.58	.....	21.20	.....
March	30.79	4.99	31.49	2.38	31.80	.....	27.70	.....	31.41	.....
April	43.51	3.32	43.21	3.49	42.70	.....	36.99	.....	40.85	.....
May	54.96	3.96	56.17	3.97	53.70	.....	49.14	.....	54.47	.....
June	65.27	2.93	65.86	2.72	63.90	.....	63.18	.....	63.81	.....
July	69.21	3.94	69.91	3.68	70.40	.....	67.15	.....	69.89	.....
August	66.56	4.92	66.80	4.17	64.70	.....	64.18	.....	67.82	.....
September	58.48	3.51	59.15	3.43	58.80	.....	57.37	.....	59.00	.....
October	46.53	4.15	48.82	4.26	46.40	.....	45.44	.....	49.22	.....
November	37.11	2.38	37.96	3.62	35.50	.....	33.67	.....	38 06	.....
December	23.68	3.37	24.87	3.01	25.20	.....	21.14	.....	25.33	.....

Months.	Fort Constitution.		Francestown.		Dartmouth College.		Hanover.		Littleton.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	24.89	2.42	18.58	.....	16.24	2.86	17.62	.....	17.57	2 59
February	26.26	2.64	24.29	.....	15.47	2.70	18.89	.....	18.40	1.49
March	34.37	2.16	30.08	.....	26.15	2.98	29.10	.....	24.44	2.16
April	43.26	3.44	42.00	.....	37.66	3.13	40.10	.....	38.62	1.90
May	53.50	3.44	53.50	.....	52.53	3.46	53.40	.....	52.84	4.68
June	62 34	3.01	64.09	.....	61.69	3.89	62.70	.....	58.91	.75
July	67.06	2.40	69.02	.....	65.68	3.41	67.15	.....	66.60	5.17
August	65.06	3.80	68.15	.....	63.34	3.79	65.60	.....	65.81	4.60
September	59.12	2.43	59.45	.....	55.55	3.17	56.36	.....	55.58	1.80
October	49.64	3.29	47.09	.....	44.30	4.01	44.18	.....	46.60	2.43
November	38.89	3.23	38.19	.....	32.31	3.40	33.76	.....	33.90	1.05
December	28.74	3.32	29.46	.....	17.08	3.52	20.99	.....	15.09	2.30

Table showing the monthly averages of temperature and rainfall, &c.—Continued.

NEW HAMPSHIRE.

Months.	Portsmouth.		Shelburne.		Stratford.		West Enfield.		Whitefield.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	25.45	.....	16.32	.....	13.27	2.77	20.10	3.72	22.50	.....
February	27.75	.....	19.26	.....	17.17	2.52	20.11	1.46	16.35	.....
March	30.85	.....	27.44	.....	24.92	3.47	27.25	2.50	24.18	.....
April	47.15	.....	39.80	.....	37.37	2.48	39.07	5.37	43.65	.....
May	57.10	.....	52.07	.....	50.84	3.31	51.77	3.25	53.23	.....
June	65.80	.....	62.91	.....	31.36	3.24	63.86	3.69	64.48	.....
July	69.65	.....	69.36	.....	65.21	4.42	68.73	9.25	67.61	.....
August	68.15	.....	64.18	.....	62.27	3.84	65.48	4.28	62.42	.....
September	60.35	.....	55.46	.....	54.46	3.98	58.26	3.69	57.68	.....
October	48.80	.....	43.78	.....	42.21	3.64	45.58	5.85	43.43	.....
November	34.80	.....	33.35	.....	31.37	3.21	31.86	2.96	31.36	.....
December	26.20	.....	20.21	.....	16.07	3.08	19.53	1.75	21.73	.....

VERMONT.

Months.	Brandon.		Burlington.		Craftsbury,		Fayetteville.		Luxenburg.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	19.29	2.81	14.40	1.76	13.51	2.44	18.40	4.94	15.68	.....
February	21.95	2.47	18.90	1.84	16.62	2.39	19.90	3.67	17.52	.....
March	28.57	2.44	28.50	2.04	24.57	2.95	31.00	4.00	26.32	.....
April	41.91	2.36	39.50	2.10	37.60	2.66	44.00	4.54	37.77	.....
May	54.75	2.83	56.30	3.29	50.72	3.02	56.20	4.70	51.84	.....
June	64.01	2.71	66.60	3.41	60.97	3.10	63.50	4.66	63.96	.....
July	68.67	4.55	68.20	4.38	65.27	4.35	67.50	5.06	67.52	.....
August	65.87	4.66	67.60	3.29	62.15	4.75	66.10	4.81	64.55	.....
September	58.43	3.18	57.10	3.60	54.70	3.95	57.40	5.37	55.64	.....
October	46.27	3.18	45.26	3.72	42.49	3.31	46.70	4.15	44.55	.....
November	36.28	3 00	33.50	2.62	31.71	3.37	34.90	5.67	32.24	.....
December	23.45	2.18	24.70	2.10	18.35	2.95	24.10	3.60	19.36	.....

Months.	Middlebury.		Montpelier.		Newbury.		New Fane.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	18.51	1.68	22.85	.....	17.58	.....	15.54	.....
February	21.30	2.90	17.86	.....	19.04	.....	22.29	.....
March	29.84	2.28	24.77	.....	29.08	.....	25.73	.....
April	42.82	2.37	38.86	.....	41.81	.....	42.38	.....
May	54.52	2.99	50.66	.....	53.87	.....	53.22	.....
June	65.78	2.39	60.67	.....	64.70	.....	64.95	.....
July	69.80	3.92	67.40	.....	69.15	.....	71.11	.....
August	66.01	3.68	63.98	.....	67.06	.....	65.55	.....
September	58.91	5.30	57.49	.....	57.60	.....	57.85	.....
October	46.93	3.17	46.40	.....	45.68	.....	47.44	.....
November	37.15	2.97	38.94	.....	35.38	.....	34.67	.....
December	23.23	2.97	23.26	.....	21.17	.....	25.62	.....

Months.	Newport.		Norwich.		Randolph.		Rutland.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	15.54	.....	6.61	.....	17.19	.....	18.00	.....
February	22.29	.....	27.17	.....	16.65	.....	18.50	.....
March	25.73	.....	24.43	.....	25.64	.....	32.00	.....
April	42.38	.....	42.05	.....	40.37	.....	41.00	.....
May	53.22	.....	51.59	.....	52.79	.....	50.00	.....
June	64.95	.....	65.50	.....	65.07	.....	64.00	.....
July	71.11	.....	69.71	.....	69.59	.....	67.50	.....
August	65.55	.....	68.12	.....	54.98	.....	67.50	.....
September	57.85	.....	65.40	.....	57.45	.....	57.00	.....
October	47.44	.....	44.63	.....	44.32	.....	41.00	.....
November	34.67	.....	32.28	.....	34.08	.....	37.00	.....
December	25.62	.....	20.73	.....	20.22	.....	30.00	.....

Table showing the monthly averages of temperature and rainfall, &c.—Continued.

VERMONT.

Months.	Saint Johnsbury.		Springfield.		Williamstown.		Woodstock.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	15.61	.....	16.19	4.54	15.34	.....	16.44	2.50
February	16.82	.....	21.19	2.37	15.72	.....	14.95	1.45
March	27.16	.....	29.24	3.40	25.45	.....	23.52	1.67
April	37.64	.....	39.38	3.59	37.93	.....	38.78	2.78
May	52.99	.....	53.33	3.53	50.12	.....	52.13	4.95
June	62.16	.....	62.00	4.03	59.45	.....	62.59	3.06
July	64.15	.....	66.08	5.15	64.04	.....	68.07	4.94
August	63.62	.....	66.37	4.13	61.36	.....	62.91	4.33
September	55.16	.....	58.67	2.70	52.98	.....	55.81	3.44
October	43.61	.....	48.37	3.94	41.79	.....	41.85	5.25
November	33.05	.....	37.56	3.02	30.08	.....	31.08	2.96
December	17.43	.....	22.87	2.75	18.06	.....	19.64	3.25

MASSACHUSETTS.

Months.	Deerfield.		Fitchburg.		Fort Warren.		Framingham.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	22.24	.....	23.80	.80	27.83	.....	22.76	.....
February	22.29	.....	31.35	3.12	27.99	.....	24.16	.....
March	30.28	.....	35.80	6.31	33.14	.....	32.89	.....
April	42.97	.....	44.82	3.95	44.49	.....	44.43	.....
May	55.38	.....	54.25	3.71	53.93	.....	55.09	.....
June	65.77	.....	66.05	2.57	65.19	.....	65.56	.....
July	70.28	.....	70.47	5.96	70.88	.....	69.01	.....
August	68.20	.....	67.65	4.18	69.96	.....	67.17	.....
September	60.43	.....	61.57	2.38	62.33	.....	59.06	.....
October	45.57	.....	52.82	4.91	51.64	.....	47.81	.....
November	37.35	.....	39.95	4.83	41.59	.....	36.97	.....
December	26.61	.....	25.88	.35	30.08	.....	24.65	.....

Months.	Georgetown.		Hinsdale.		Ipswich.		Kingston.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	22.57	.....	24.13	.....	30.00	.....	28.05	.....
February	25.68	.....	21.15	.....	30.00	.....	28.65	.....
March	32.57	.....	23.87	.....	38.00	.....	31.47	.....
April	44.94	.....	42.08	.....	48.00	.....	43.53	.....
May	52.21	.....	53.65	.....	56.50	.....	51.89	.....
June	65.26	.....	64.76	.....	68.00	.....	64.02	.....
July	68.71	.....	69.59	.....	70.50	.....	70.12	.....
August	68.52	.....	66.27	.....	70.00	.....	67.98	.....
September	60.33	.....	58.54	.....	63.50	.....	61.97	.....
October	47.02	.....	43.08	.....	51.60	.....	51.16	.....
November	38.35	.....	33.00	.....	39.00	.....	41.87	.....
December	26.44	.....	23.17	.....	37.00	.....	31.14	.....

Months.	Lawrence.		Lenox.		Medfield.		Mendon.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	23.21	3.75	22.77	.....	23.81	.....	24.35	.....
February	25.65	2.69	16.77	.....	26.10	.....	24.10	.....
March	31.23	3.56	29.92	.....	34.53	.....	32.03	.....
April	42.19	4.28	37.24	.....	43.69	.....	44.00	.....
May	53.21	4.05	51.51	.....	54.48	.....	54.44	.....
June	64.26	3.09	63.27	.....	64.69	.....	64.53	.....
July	69.13	3.82	64.92	.....	68.92	.....	70.47	.....
August	67.86	5.28	64.36	.....	58.09	.....	67.70	.....
September	59.83	3.25	54.62	.....	59.21	.....	59.93	.....
October	47.98	3.27	42.86	.....	49.17	.....	48.53	.....
November	38.41	3.72	32.79	.....	38.56	.....	38.78	.....
December	26.32	4.20	21.93	.....	29.68	.....	27.00	.....

Table showing the monthly averages of temperature and rainfall, &c.—Continued.

MASSACHUSETTS.

Months.	Milton.		Nantucket.		New Bedford.		Newbury.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	27.00	.....	32.07	3.92	28.79	3.34	23.30	.....
February	27.59	.....	31.98	2.81	29.44	3.30	25.80	.....
March	32.34	.....	36.56	3.25	35.50	3.56	32.63	.....
April	44.89	.....	44.59	4.02	44.66	3.53	45.07	.....
May	54.44	.....	52.76	3.75	54.24	3.64	53.49	.....
June	65.61	.....	63.17	3.27	63.50	2.83	66.26	.....
July	70.70	.....	70.10	2.48	69.12	2.98	70.59	.....
August	69.32	.....	68.84	2.72	68.23	3.94	67.40	.....
September	61.13	.....	64.13	3.16	62.05	3.29	57.29	.....
October	50.20	.....	55.36	3.57	52.29	3.36	46.62	.....
November	39.15	.....	45.63	3.38	42.48	3.87	38.11	.....
December	28.85	.....	36.57	4.77	32.40	3.78	27.20	.....

Months.	Newburyport.		Princeton.		Sandwich.		Topsfield.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	23.14	.....	20.24	.....	26.23	.....	25.27	.....
February	23.54	.....	17.61	.....	29.73	.....	27.21	.....
March	30.79	.....	25.68	.....	37.48	.....	33.52	.....
April	42.99	.....	41.18	.....	45.01	.....	44.75	.....
May	53.57	.....	52.83	.....	53.78	.....	54.30	.....
June	64.07	.....	62.85	.....	61.42	.....	64.90	.....
July	70.10	.....	69.46	.....	69.16	.....	69.91	.....
August	65.95	.....	64.38	.....	70.29	.....	68.32	.....
September	61.41	.....	58.73	.....	59.40	.....	60.53	.....
October	49.59	.....	49.16	.....	50.92	.....	48.87	.....
November	38.88	.....	37.45	.....	43.43	.....	40.49	.....
December	28.06	.....	24.45	.....	32.17	.....	28.32	.....

RHODE ISLAND.

Months.	Fort Wolcott.		Newport.		North Scituate.		Providence.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	29.49	.....	29.93	3.37	24.33	.....	25.84	3.42
February	30.48	.....	29.40	5.41	25.71	.....	27.01	2.88
March	27.24	.....	36.14	5.11	34.07	.....	34.43	3.46
April	46.02	.....	44.51	1.74	42.20	.....	45.64	3.59
May	55.54	.....	53.88	4.50	56.95	.....	55.75	3.49
June	64.52	.....	64.70	4.13	66.38	.....	63.85	3.13
July	70.41	.....	70.14	1.81	68.70	.....	70.93	3.08
August	69.59	.....	69.52	3.78	63.42	.....	69.08	3.93
September	63.22	.....	63.43	2.60	60.09	.....	61.73	3.09
October	54.30	.....	53.55	3.49	47.02	.....	50.85	3.35
November	43.03	.....	43.27	4.52	39.31	.....	40.45	4.04
December	34.29	.....	34.16	4.91	26.01	.....	29.37	3.92

CONNECTICUT.

Months.	Canton.		Colebrook.		Columbia.		Goshen.		Litchfield.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	27.87	4.24	20.89	.....	25.88	.....	26.55	.....	24.02	.....
February	25.11	3.87	23.31	.....	28.87	.....	26.12	.....	26.19	.....
March	29.63	6.14	28.70	.....	33.94	.....	34.00	.....	32.92	.....
April	40.51	1.81	43.12	.....	45.76	.....	45.92	.....	38.88	.....
May	54.15	2.76	53.84	.....	56.52	.....	56.11	.....	51.45	.....
June	58.93	6.93	64.55	.....	65.87	.....	65.26	.....	62.58	.....
July	68.79	9.29	69.38	.....	70.62	.....	70.53	.....	68.06	.....
August	64.03	4.36	67.13	.....	68.87	.....	69.06	.....	64.39	.....
September	59.67	3.39	59.40	.....	61.73	.....	60.89	.....	58.48	.....
October	50.24	4.04	47.30	.....	51.13	.....	49.95	.....	49.44	.....
November	39.10	5.46	36.61	.....	40.65	.....	39.89	.....	35.52	.....
December	29.51	2.56	24.67	.....	29.25	.....	29.05	.....	25.08	.....

Table showing the monthly averages of temperature and rainfall, &c.—Continued.

CONNECTICUT.

Months.	Middletown.		Plymouth.		Pomfret.		Salisbury.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	26.23	3.41	26.00	3.25	22.89	3.97	24.65	2.29
February	28.93	3.24	26.29	3.33	28.07	3.32	25.28	2.79
March	33.86	3.18	27.98	4.36	30.99	3.53	34.65	2.62
April	45.66	3.35	41.70	2.77	43.30	3.62	44.44	2.89
May	56.24	3.96	56.42	3.72	53.77	3.77	56.32	4.62
June	66.34	2.22	62.18	1.67	63.17	3.86	65.87	4.01
July	70.96	3.50	68.83	8.91	68.12	4.59	70.44	4.71
August	68.97	6.60	67.80	4.31	65.82	4.64	68.06	3.60
September	61.43	2.13	57.85	2.81	58.85	3.47	60.09	3.26
October	50.80	5.09	48.74	4.33	48.46	3.76	50.18	4.68
November	38.95	3.70	38.97	5.45	42.36	4.24	39.23	4.90
December	28.67	3.82	25.97	3.78	26.28	4.34	27.54	4.67

Months.	Sharon.		Wallingford.		Warren Centre.		Waterbury.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	24.90	.....	24.42	4.85	21.70	.....	24.52	.....
February	26.15	.....	27.85	3.02	20.66	.....	27.55	.....
March	34.42	.....	34.79	4.35	35.31	.....	33.62	.....
April	45.64	.....	44.72	4.43	41.21	.....	44.93	.....
May	57.65	.....	54.99	5.09	52.41	.....	54.26	.....
June	65.96	.....	65.77	4.82	64.31	.....	64.78	.....
July	70.11	.....	69.76	4.20	67.67	.....	70.92	.....
August	68.00	.....	67.36	6.62	67.34	.....	69.05	.....
September	61.14	.....	60.49	4.36	58.41	.....	60.32	.....
October	49.96	.....	50.82	3.05	48.32	.....	45.22	.....
November	39.29	.....	39.28	2.98	45.46	.....	38.01	.....
December	28.73	.....	28.40	4.26	27.23	.....	24.65	.....

NEW YORK.

Months.	Amenia.		Auburn.		Baldwinsville.		Belleville (Union Academy).	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	21.79	.....	24.37	2.50	22.62	.....	23.73	.....
February	20.12	.....	25.08	2.04	24.69	.....	22.92	.....
March	35.56	.....	33.51	2.13	30.39	.....	32.64	.....
April	41.54	.....	45.26	2.22	42.09	.....	48.18	.....
May	56.66	.....	54.84	3.45	53.75	.....	56.50	.....
June	66.55	.....	64.47	3.57	64.17	.....	64.68	.....
July	68.88	.....	69.38	3.13	68.79	.....	69.59	.....
August	67.86	.....	68.23	3.23	69.03	.....	66.13	.....
September	57.76	.....	59.45	3.20	59.08	.....	60.04	.....
October	46.99	.....	48.23	3.38	47.29	.....	48.98	.....
November	45.15	.....	37.75	2.85	37.72	.....	37.77	.....
December	28.24	.....	29.54	2.72	26.76	.....	25.93	.....

Months.	Bellport.		Bridgewater.		Buffalo.		Cambridge (Washington County Academy).	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	31.12	5.42	20.64	.....	24.36	2.46	22.44	2.90
February	30.70	4.75	21.89	.....	26.39	2.56	21.45	2.59
March	37.29	4.07	29.88	.....	31.37	3.45	32.69	2.03
April	45.01	3.14	42.29	.....	43.63	2.91	44.19	2.98
May	54.35	2.95	52.98	.....	53.59	3.53	55.99	3.49
June	64.32	3.75	59.58	.....	65.04	2.46	64.82	4.30
July	69.17	3.04	66.64	.....	69.58	2.76	68.88	3.58
August	68.58	3.73	69.90	.....	68.58	3.02	66.09	4.18
September	62.10	6.03	55.44	.....	61.19	3.65	58.29	2.76
October	53.14	2.74	44.66	.....	49.51	3.16	46.76	3.48
November	42.54	3.84	31.42	.....	40.13	2.99	36.56	2.80
December	33.63	1.96	23.68	.....	28.40	3.40	26.21	2.14

Table showing the monthly averages of temperature and rainfall, &c.—Continued.

NEW YORK.

Months.	Canajoharie (academy).		Canandaigua (academy).		Cazenovia.		Charlotte.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	20.97	.....	23.34	3	21.43	3.25	25.47	1.73
February	19.61	.....	21.09	3.43	22.21	3.08	27.88	1.72
March	30.46	.....	31.84	2.31	29.85	3.92	32.93	2.28
April	47.29	.....	45.94	2.42	42.87	4.35	44.57	2.41
May	58.33	.....	55.92	4.91	53.00	3.26	54.69	2.92
June	64.06	.....	65.70	3.74	61.99	4.12	66.33	2.43
July	70.34	.....	69.49	3.30	66.71	4.59	70.65	2.90
August	67.36	.....	66.80	3.47	64.61	4.02	69.76	2.95
September	58.69	.....	57.32	2.83	57.66	3.90	62.22	2.89
October	49.06	.....	47.85	3.13	45.84	4.29	50.68	3.03
November	37.87	.....	36.14	2.82	35.63	3.17	40.83	2.56
December	25.26	.....	26.68	2.56	24.69	3.15	29.23	2.09

Months.	Cherry Valley Academy.		Clyde.		Cuba.		Dansville.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	22.03	2.66	23.82	.....	18.10	2.78	28.82	.....
February	21.66	2.57	27.35	.....	22.48	1.96	31.53	.....
March	30.30	2.80	30.96	.....	28.02	3.72	32.35	.....
April	43.64	3.03	44.77	.....	40.41	3.13	46.87	.....
May	53.84	4.04	53.65	.....	51.21	2.54	52.20	.....
June	63.48	4.35	63.61	.....	62.60	3.43	65.22	.....
July	67.68	4.24	66.77	.....	63.52	2.21	68.95	.....
August	65.58	3.45	65.25	.....	63.22	3.27	68.01	.....
September	57.82	3.55	59.47	.....	55.12	3.47	60.80	.....
October	45.81	3.90	50.62	.....	40.19	2.52	52.12	.....
November	34.36	3.18	37.38	.....	32.61	2.73	37.50	.....
December	25.34	3.07	31.95	.....	23.58	2.97	34.03	.....

Months.	Delhi.		Depauville.		East Hampton.		Ellisburg.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	22.82	.....	19.24	3.32	30.13	2.93	23.74	.....
February	28.58	.....	20.76	3.98	30.75	2.30	22.82	.....
March	33.59	.....	29.20	3.20	36.66	2.54	33.42	.....
April	39.49	.....	42.82	2.29	44.43	3.82	48.65	.....
May	55.30	.....	53.10	3.74	53.18	3.66	57.49	.....
June	68.05	.....	64.85	4.08	62.80	2.98	64.73	.....
July	68.95	.....	69.57	2.81	69.68	2.54	69.73	.....
August	64.69	.....	66.49	5.30	68.51	3.22	66.94	.....
September	55.86	.....	60.32	5.01	62.54	3.27	61.34	.....
October	45.92	.....	46.36	5	52.13	3.65	48.72	.....
November	37.01	.....	35.96	5.23	42.27	3.16	38.39	.....
December	31.45	.....	23.72	4.21	33.45	3.17	36.53	.....

Months.	Elmira.		Fairfield Academy.		Fort Edward.		Fort Niagara.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	19.50	.....	19.73	2.69	25.31	4.72	26.71	.....
February	26.66	.....	19.73	1.79	21	1.72	26.98	.....
March	32.15	.....	29.85	2.36	33.13	2.84	33.34	.....
April	39.85	.....	42.57	2.53	45.45	4	43.32	.....
May	56.09	.....	53.91	3.09	57.79	5.26	54.59	.....
June	62.80	.....	62.53	4.29	69.96	7.85	65.12	.....
July	67.81	.....	66.39	4.21	70.74	4.92	70.53	.....
August	64.29	.....	65.79	3.65	67.57	4.71	69.56	.....
September	58.55	.....	57.53	3.08	60.85	4.27	61.62	.....
October	51.02	.....	46.02	3.56	49.09	8.57	50.49	.....
November	33.90	.....	34.50	2.46	36.06	6.11	39.75	.....
December	32.86	.....	23.98	2.74	27.60	5.76	29.17	.....

Table showing the monthly averages of temperature and rainfall, &c.—Continued.

NEW YORK.

Months.	Fort Ontario.		Fredonia (academy).		Friendship.		Goshen.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	24.21	.....	28.37	2.04	15.75	.....	25.66	.....
February	23.26	.....	27.75	1.82	29.72	.....	26.31	.....
March	30.94	.....	35.16	1.99	27.71	.....	36.51	.....
April	42.87	.....	45.85	1.93	43.05	.....	47.42	.....
May	51.76	.....	56.67	3.32	47.95	.....	56.22	.....
June	62.23	.....	65.23	3.83	65.90	.....	64.73	.....
July	69.57	.....	70.66	3.34	66.18	.....	68.70	.....
August	68.28	.....	68.47	3.78	65.23	.....	67.64	.....
September	61.56	.....	61.01	4.46	56.93	.....	59.76	.....
October	48.49	.....	50.93	4.31	45.65	.....	48.81	.....
November	38.55	.....	39.71	3.27	38.07	.....	38.79	.....
December	26.74	.....	31.06	2.96	22.52	.....	28.01	.....

Months.	Gouverneur.		Greenville.		Hamilton.		Hartwick.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	17.23	.....	30.27	.....	22.91	.....	24.27	.....
February	18.17	.....	27.48	.....	22.95	.....	25.22	.....
March	28.56	.....	33.78	.....	31.80	.....	35.89	.....
April	42.89	.....	40.18	.....	45.43	.....	44.42	.....
May	54.81	.....	62.51	.....	54.97	.....	56.48	.....
June	64.11	.....	66.78	.....	63.08	.....	65.08	.....
July	69.70	.....	68.88	.....	67.36	.....	68.25	.....
August	66.71	.....	68.72	.....	65.86	.....	66.72	.....
September	56.67	.....	61.73	.....	58.28	.....	58.75	.....
October	45.59	.....	51.26	.....	45.88	.....	48.46	.....
November	33.73	.....	36.96	.....	35.64	.....	38.11	.....
December	20.94	.....	28.13	.....	26.36	.....	28.19	.....

Months.	Henrietta.		Hermitage.		Homer (Cortland Academy).		Houseville.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	29.70	.....	23.26	5.19	22.90	1.72	20.92	1.96
February	28.48	.....	23.44	3.64	22.51	2.89	21.40	2.92
March	38.44	.....	26.74	4.28	31.12	2.66	28.37	3.03
April	48.31	.....	39.40	3.76	42.40	3.41	38.89	3.03
May	58.70	.....	50.74	4.64	53.93	5.06	51.56	3.03
June	64.95	.....	60.57	3.40	61.67	4.36	64.97	2.13
July	69.76	.....	64.49	4.96	65.92	6.51	69.16	4.45
August	66.57	.....	64.31	5.10	64.22	3.04	65.18	3.49
September	60.07	.....	56.31	3.70	56.45	4.39	57.79	4.03
October	51.31	.....	46.62	4.80	46.53	4.36	46.81	4.55
November	39.48	.....	35.46	4.76	35.81	4.79	34.28	4.00
December	30.76	.....	26.64	3.50	26.96	3.79	20.24	2.42

Months.	Ithaca (academy).		Jamestown.		Johnstown (academy).		Kinderhook (academy).	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	27.78	.....	20.20	2.75	21.27	.....	22.90	2.21
February	27.78	.....	24.58	3.05	22.14	.....	23.32	1.53
March	34.90	.....	32.68	3.10	31.68	.....	33.74	2.48
April	46.73	.....	43.38	3.65	43.50	.....	46.30	2.97
May	57.82	.....	57.16	4.40	55.89	.....	57.26	3.41
June	65.42	.....	65.98	3.90	64.76	.....	65.44	4.55
July	70.78	.....	68.67	5.40	68.89	.....	70.15	4.35
August	68.68	.....	66.26	5.90	67.70	.....	68.47	3.35
September	60.35	.....	60.94	6.35	58.16	.....	60.30	2.94
October	49.20	.....	48.39	4.55	46.73	.....	47.54	3.25
November	38.97	.....	36.62	5.35	34.97	.....	38.28	3.69
December	31.02	.....	29.28	5.55	24.83	.....	25.24	2.75

Table showing the monthly averages of temperature and rainfall, &c.—Continued.

NEW YORK.

Months.	Leyden.		Liberty.		Little Genesee.		Lockport.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rain. fall.	Temp.	Rainfall.
January	22.76		18.19	1.64	22.13		24.2	
February	16.01		20.13	5.72	23.58		27.6	
March	25.58		26.71	4.93	28.65		33.2	
April	40.25		39.95	7.48	43.26		40.4	
May	52.73		51.59	3.39	52.38		53.7	
June	57.82		62.62	4.77	65.44		66.3	
July	66.33		68.79	2.73	68.97		68.8	
August	61.35		64.34	3.53	64.97		66.7	
September	59.05		56.63	2.79	58.50		59.6	
October	39.74		47.84	2.86	45.27		49.9	
November	28.53		33.95	3.88	35.58		43.9	
December	23.52		26.32	4.46	24.47		34.4	

Months.	Lowville.		Lyons.		McGrawville.		Madison Barracks.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	19.75		24.90		9.23		21.79	
February	21.49		26.22		30.52		23.81	
March	29.78		31.80		25.65		32.89	
April	43.70		42.64		35.72		44.35	
May	54.59		54.73		51.98		54.56	
June	62.61		63.06		61.16		64.49	
July	67.91		67.12		70.01		69.08	
August	64.84		66.39		64.66		68.96	
September	57.43		57.94		59.43		60.62	
October	45.80		49.67		46.48		49.49	
November	34.45		38.04		35.46		37.88	
December	23.40		28.90		32.07		25.87	

Months.	Malone (Franklin Academy).		Mexico (academy).		Middleburg.		Milo.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	18.24		21.90		26.87		28.53	
February	24.48		23.39		26.28		21.25	
March	31.42		30.88		33.96		25.43	
April	45.07		41.93		45.59		44.38	
May	53.01		52.23		56.00		55.14	
June	60.22		62.84		63.89		66.12	
July	66.90		66.89		68.75		68.74	
August	55.45		65.86		66.91		67.09	
September	55.17		58.63		59.14		61.24	
October	46.92		46.40		48.00		45.96	
November	32.85		34.78		37.22		35.44	
December	21.22		25.95		29.17		27.71	

Months.	Millville (academy).		Mohawk.		Newark Valley.		North Granville.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	26.00		20.87		24.14		20.67	
February	26.36		22.69		20.69		20.09	
March	32.28		28.04		27.05		31.29	
April	45.55		42.33		41.77		43.63	
May	54.69		54.89		54.65		56.15	
June	63.23		64.59		65.52		66.50	
July	68.24		69.64		70.80		70.82	
August	67.73		67.73		66.45		68.28	
September	59.50		58.77		58.74		58.72	
October	46.63		47.93		45.22		47.70	
November	37.76		36.87		35.03		35.89	
December	28.99		23.12		26.43		24.79	

Table showing the monthly averages of temperature and rainfall, &c.—Continued.

NEW YORK.

Months.	Ogdensburg (academy).		Oneida.		Onondaga.		Oswego.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	20.08	.....	23.33	.....	25.28	2.01	24.12	3.29
February	20.20	.....	24.32	.....	25.67	1.49	25.43	3.37
March	30.51	.....	30.45	.....	33.81	1.82	31.32	3.96
April	40.05	.....	44.66	.....	45.97	2.12	42.10	4.28
May	52.95	.....	55.70	.....	58.01	3.20	52.88	4.22
June	64.45	.....	65.37	.....	65.49	3.74	63.15	3.23
July	68.68	.....	70.14	.....	68.91	3.12	69.57	3.82
August	67.92	.....	67.69	.....	68.05	3.62	68.10	3.50
September	57.65	.....	60.77	.....	59.75	2.76	61.28	4.19
October	48.51	.....	48.39	.....	48.26	3.10	49.74	4.50
November	39.36	.....	37.82	.....	36.54	2.66	40.40	4.58
December	22.88	.....	27.12	.....	29.12	1.99	28.05	4.00

Months.	Oxford (academy).		Palermo.		Penn Yan.		Plattsburg.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	22.90	.....	20.84	.....	25.60	.....	18.68	1.38
February	23.59	.....	21.99	.....	25.54	.....	19.54	1.20
March	31.98	.....	28.01	.....	33.40	.....	28.51	2.18
April	43.98	.....	42.23	.....	44.16	.....	41.52	2.50
May	55.33	.....	53.76	.....	55.28	.....	54.76	3.63
June	63.44	.....	64.40	.....	64.42	.....	64.34	3.51
July	67.98	.....	69.19	.....	69.22	.....	68.73	3.22
August	65.81	.....	66.72	.....	66.81	.....	66.90	3.30
September	58.18	.....	58.74	.....	59.48	.....	59.01	3.72
October	46.58	.....	46.65	.....	47.88	.....	46.09	3.67
November	35.59	.....	36.10	.....	38.22	.....	35.45	2.66
December	26.09	.....	24.55	.....	28.44	.....	23.15	2.37

Months.	Pompey.		Potsdam.		Prattsburg.		Rochester.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rain fall.
January	21.43	1.69	18.41	1.40	24.47	.....	25.49	2.49
February	21.73	1.60	18.78	1.06	24.61	.....	25.91	2.31
March	29.28	1.26	29.96	1.48	32.99	.....	32.73	2.97
April	40.80	1.77	43.75	1.70	46.15	.....	45.21	2.73
May	52.33	3.08	55.03	3.02	52.88	.....	56.23	3.12
June	61.65	4.21	68.96	3.31	61.28	.....	65.63	2.92
July	65.95	4.12	68.39	4.03	66.77	.....	70.38	3.37
August	64.29	3.19	66.75	2.81	65.86	.....	68.10	3.22
September	55.55	2.93	57.37	3.11	57.47	.....	60.43	3.36
October	44.46	3.23	44.99	3.34	54.93	.....	48.53	3.64
November	32.71	2.10	33.72	1.93	35.21	.....	38.09	2.58
December	24.07	1.57	22.11	1.44	28.19	.....	27.91	2.96

Months.	Rouse's Point.		Sacket's Harbor.		Salem.		Schenectady.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	18.02	.....	21.14	1.98	22.42	.....	22.09	.....
February	18.91	.....	24.14	2.46	22.75	.....	21.79	.....
March	29.21	.....	30.36	2.89	32.57	.....	30.43	.....
April	40.23	.....	43.64	2.95	45.65	.....	44.58	.....
May	54.66	.....	54.37	3.36	57.03	.....	59.05	.....
June	46.63	.....	65.20	2.51	65.94	.....	66.67	.....
July	68.89	.....	70.06	2.98	69.29	.....	70.15	.....
August	66.81	.....	70.26	3.10	69.55	.....	68.09	.....
September	57.59	.....	61.50	3.44	60.06	.....	59.84	.....
October	46.45	.....	50.07	4.01	46.63	.....	47.09	.....
November	36.53	.....	40.77	4.13	38.55	.....	37.54	.....
December	21.74	.....	25.89	2.92	28.31	.....	29.22	.....

Table showing the monthly averages of temperature and rainfall, &c.—Continued.

NEW YORK.

Months.	Skaneateles.		Smithville.		South Edmeston.		South Trenton.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	23.55		21.38		23.13		19.10	3.57
February	27.06		21.01		26.77		21.08	5.16
March	30.02		28.60		31.40		25.97	4.61
April	43.07		42.08		44.88		39.01	4.00
May	53.41		52.40		54.79		51.66	3.81
June	63.09		63.57		66.57		66.06	4.75
July	67.88		70.71		70.25		69.29	4.51
August	65.18		67.70		67.29		65.38	4.64
September	60.72		60.04		54.09		60.39	5.26
October	47.27		47.59		50.66		45.27	4.65
November	37.18		40.14		41.78		34.28	3.62
December	26.25		22.61		23.12		22.90	4.20

Months.	Springville (academy).		Syracuse (academy).		Theresa.		Utica.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	24.88	1.18	24.15		15.59		23.28	2.89
February	25.95	2.37	26.62		20.17		24.28	2.66
March	30.75	1.84	32.25		27.09		32.43	2.70
April	45.45	3.95	42.41		41.92		45.20	3.29
May	53.14	2.17	55.50		54.68		56 68	3.31
June	61.62	3.95	65.58		64.20		64.67	4.62
July	67.51	3.60	70.82		68.50		69.88	4.74
August	64.18	3.64	68.60		67.46		67.67	3.65
September	57.61	4.60	61.38		58.96		59.58	3.48
October	46.23	5.82	50.44		45.23		48.58	2.84
November	37.50	3.03	36.36		35.38		36.83	3.61
December	28.41	2.30	29.95		23.94		26.56	3.35

Months.	Wampsville.		Waterburg.		Waterville.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	21.72	3.88	25.40		25.04	
February	24.32	3.19	22.73		26.03	
March	30.31	3.78	24.41		29.76	
April	42.66	5.40	43.46		39.27	
May	55.98	6.15	54.89		49.81	
June	64.61	5.65	65.51		66.37	
July	70.29	7.34	69.36		69.91	
August	66.42	8.15	65.93		67.28	
September	59.45	7.20	58.93		57.35	
October	47.87	6.27	44.13		44.99	
November	38.05	5.99	33.14		44.17	
December	25.57	3.97	25.22		24.29	

Months.	White Plains.		Youngsville.		Newark.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	27.51		15.08		31.63	3.52
February	29.65		31.28		25.90	3.34
March	34.40		29.48		34.45	3.46
April	47.56		37.22		45.62	3.67
May	57.00		52.16		56.31	4.36
June	67.38		61.34		66.01	3.20
July	70.92		68.36		70.51	3.66
August	69.97		66.02		69.04	4.72
September	63.04		57.56		60.71	3.47
October	52.28		44.96		49.86	3.58
November	42.81		36.50		39.92	3.79
December	31.05		24.26		29.05	4.08

Table showing the monthly averages of temperature and rainfall, &c.—Continued.

PENNSYLVANIA.

Months.	Abington.		Blairsville.		Blooming Grove.		Ceres.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	23.93		22.70		21.81		23.36	2.95
February	26.11		28.20		23.63		23.55	3.45
March	31.97		34.30		29.25		32.34	2.35
April	45.31		42.10		43.99		42.84	3.50
May	55.15		52.40		52.96		56.06	5.40
June	65.95		54.90		64.61		64.63	5.55
July	69.98		64.80		68.66		68.55	4.87
August	67.12		66.00		64.58		66.62	3.13
September	60.78		52.80		59.23		59.06	5.33
October	47.39		47.70		44.78		45.76	8.20
November	37.90		40.20		35.60		36.19	5.33
December	27.40		28.00		24.62		27.08	4.72

Months.	Dyberry.		Pennsville.		Sewickleyville.		Somerset.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	20.13		21.10		27.12	4.90	25.43	2.45
February	22.36		23.56		32.25	4.63	27.46	2.34
March	29.15		30.17		36.33	1.51	34.37	2.00
April	43.37		43.42		47.92	4.61	45.53	4.26
May	50.76		52.83		53.42	2.85	55.49	4.76
June	65.14		65.32		68.27	4.03	64.83	4.10
July	67.16		69.14		67.25	5.94	67.28	3.00
August	62.54		65.70		69.20	3.46	65.72	3.42
September	58.21		58.97		61.40	5.27	58.82	2.98
October	43.98		44.74		48.36	2.92	47.30	2.93
November	35.19		34.71		37.52	4.31	37.90	3.50
December	30.58		23.97		29.55	0.95	28.69	3.00

Months.	St. Vincent's College.		Smithport.		Worthington.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	32.23		33.51		29.27	
February	34.62		29.83		30.95	
March	39.04		32.52		39.41	
April	48.85		45.34		47.70	
May	58.42		54.13		59.86	
June	68.82		62.72		65.93	
July	70.77		67.00		69.21	
August	70.60		64.05		68.88	
September	63.27		55.11		61.07	
October	54.25		48.40		50.88	
November	39.65		32.20		40.13	
December	36.38		25.03		29.84	

OHIO.

Months.	East Cleveland.		East Fairfield.		Granville.		Little Mountain.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	27.71		25.45		26.23	2.47	25.53	
February	28.67		29.94		27.84	3.65	27.94	
March	34.89		35.00		34.76	3.35	29.79	
April	48.00		48.73		47.06	3.64	46.26	
May	53.45		56.99		55.44	3.53	55.75	
June	63.41		66.50		63.93	5.59	65.74	
July	67.13		70.35		67.17	4.82	69.83	
August	66.44		68.97		65.56	6.52	69.57	
September	61.95		62.59		58.33	2.70	62.66	
October	48.02		49.67		46.15	3.03	49.73	
November	37.81		40.18		36.75	4.11	41.44	
December	32.05		29.89		29.74	5.21	28.15	

Table showing the monthly averages of temperature and rainfall, &c.—Continued.

OHIO.

Months.	Madison.		Montville.		Newark.		Norwalk.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	26.54	2.41	29.45	1.05	26.07	.....	25.29	2.95
February	27.43	2.71	29.24	2.11	30.04	.....	29.34	1.89
March	34.23	3.26	36.42	1.60	37.13	.....	35.02	2.46
April	45.32	5.11	45.84	4.40	49.91	.....	47.70	2.59
May	55.64	4.53	57.19	5.13	56.22	.....	55.95	2.98
June	65.43	4.43	65.57	5.21	65.45	.....	66.66	3.43
July	70.41	4.26	70.07	6.97	70.00	.....	70.64	4.13
August	68.26	4.64	68.85	2.46	69.90	.....	68.78	3.30
September	62.07	4.18	62.30	1.27	61.22	.....	61.64	3.24
October	50.42	4.44	50.94	3.39	52.32	.....	50.67	2.73
November	39.19	6.12	38.27	4.33	38.51	.....	40.31	2.40
December	30.86	2.91	31.38	5.36	32.26	.....	30.35	2.04

Months.	Saybrook.		Seville.		Tarlton.		Windham.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	21.32	.....	26.86	3.20	30.93	.....	32.36	.....
February	26.87	.....	33.60	2.13	35.96	.....	27.42	.....
March	33.90	.....	35.43	2.67	41.61	.....	37.02	.....
April	47.73	.....	48.72	2.06	46.07	.....	43.56	.....
May	55.75	.....	53.02	3.15	58.71	.....	57.09	.....
June	67.18	.....	67.65	.78	64.73	.....	65.37	.....
July	69.36	.....	69.75	1.72	69.71	.....	70.80	.....
August	68.69	.....	63.45	3.86	64.23	.....	68.12	.....
September	63.93	.....	63.10	3.40	64.47	.....	62.24	.....
October	48.44	.....	53.60	3.46	49.55	.....	49.64	.....
November	40.01	.....	38.80	2.05	38.67	.....	37.61	.....
December	31.50	.....	34.98	2.04	30.13	.....	32.50	.....

INDIANA.

Months.	Laporte.		Months.	Laporte.	
	Temp.	Rainfall.		Temp.	Rainfall.
January	25.00	1.35	July	64.00	2.88
February	28.00	.....	August	65.00	9.62
March	36.00	3.50	September	54.00	2.25
April	40.00	1.25	October	45.00	4.00
May	50.00	6.12	November	34.00	8.37
June	60.00	2.50	December	20.00	1.30

ILLINOIS.

Months.	Chicago.		Elgin.		Evanston.		Farm Ridge.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	23.01	.....	23.01	1.40	23.49	.....	20.19	.....
February	24.96	.....	20.62	1.73	25.86	.....	26.05	.....
March	32.01	.....	36.85	2.00	34.32	.....	40.00	.....
April	45.31	.....	45.13	2.37	45.63	.....	46.73	.....
May	53.34	.....	56.99	1.60	55.89	.....	62.43	.....
June	61.59	.....	66.26	2.00	66.15	.....	66.10	.....
July	70.34	.....	70.26	3.38	70.20	.....	69.48	.....
August	68.34	.....	69.40	3.33	70.43	.....	68.13	.....
September	60.19	.....	59.91	3.32	66.75	.....	59.08	.....
October	48.41	.....	48.63	2.45	49.63	.....	49.86	.....
November	36.36	.....	34.59	0.66	39.78	.....	31.50	.....
December	26.38	.....	22.11	0.54	23.89	.....	18.73	.....

Table showing the monthly averages of temperature and rainfall, &c.—Continued.

MICHIGAN.

Months.	Central Mine.		Copper Falls Mine.		Dearbornville.		Detroit.		Eagle River.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	14.24	.....	8.15	5.00	24.99	.....	25.84	2.89	10.93	.....
February	12.01	.....	6.85	1.88	21.26	.....	25.89	3.30	11.13	.....
March	21.51	.....	18.05	1.35	33.79	.....	34.11	3.51	18.93	.....
April	34.02	.....	31.85	1.80	43.42	.....	46.18	4.00	38.63	.....
May	48.18	.....	46.70	1.89	54.73	.....	56.09	3.47	49.50	.....
June	58.93	.....	56.70	2.84	64.82	.....	65.43	4.99	61.46	.....
July	64.58	.....	65.85	2.00	69.95	.....	69.60	6.03	68.16	.....
August	60.63	.....	61.35	3.89	65.32	.....	69.11	3.43	61.08	.....
September	52.80	.....	50.40	6.80	58.00	.....	58.51	5.10	54.61	.....
October	39.79	.....	42.00	3.60	51.76	.....	49.85	3.56	47.21	.....
November	29.08	.....	28.90	4.30	35.01	.....	38.14	4.14	29.63	.....
December	17.26	.....	17.60	6.56	24.26	.....	28.09	3.76	17.85	.....

Months.	Eureka Valley.		Fort Brady.		Fort Gratiot.		Fort Mackinac.		Fort Wilkins.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	17.57	.....	16.73	1.76	25.42	.....	19.10	.....	23.40	.....
February	19.59	.....	15.89	1.05	25.39	.....	17.27	.....	21.40	.....
March	23.98	.....	24.77	1.30	32.72	.....	25.69	.....	28.93	.....
April	35.73	.....	38.39	1.73	44.30	.....	37.32	.....	38.07	.....
May	51.25	.....	49.67	2.03	54.26	.....	48.18	.....	48.42	.....
June	59.08	.....	59.57	2.71	63.79	.....	57.72	.....	56.68	.....
July	66.80	.....	65.50	3.58	69.81	.....	64.90	.....	63.55	.....
August	64.78	.....	63.10	3.30	67.95	.....	64.17	.....	62.17	.....
September	59.18	.....	54.75	4.50	60.01	.....	55.30	.....	55.79	.....
October	40.68	.....	43.88	3.21	48.78	.....	45.32	.....	42.91	.....
November	29.33	.....	32.60	2.97	38.28	.....	34.14	.....	30.17	.....
December	21.80	.....	21.44	2.18	27.19	.....	23.14	.....	20.55	.....

Months.	Grand Haven.		Holland.		Homestead.		Lansing.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	25.80	1.64	24.71	2.90	21.50	.....	23.61	.....
February	25.53	1.28	26.51	2.02	23.47	.....	25.36	.....
March	32.98	1.16	32.10	3.31	25.65	.....	32.50	.....
April	45.25	1.00	44.31	2.62	41.47	.....	46.59	.....
May	56.08	3.07	54.58	3.56	51.65	.....	56.51	.....
June	65.40	1.69	66.01	2.13	65.64	.....	67.20	.....
July	70.12	1.66	70.48	3.16	67.13	.....	70.65	.....
August	70.27	3.87	65.82	3.44	62.09	.....	67.43	.....
September	60.38	3.29	58.15	5.75	59.76	.....	59.88	.....
October	49.83	3.06	47.70	3.38	46.29	.....	45.72	.....
November	38.00	2.64	37.78	3.25	37.62	.....	37.29	.....
December	28.73	1.58	28.24	3.19	25.65	.....	25.90	.....

Months.	Laphamsville.		Marquette.		Mill Point.		Northport.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	28.90	.....	18.65	2.10	20.62	.....	22.54	.....
February	32.65	.....	17.92	2.17	22.70	.....	22.08	.....
March	39.33	.....	25.74	1.99	29.57	.....	26.21	.....
April	43.87	.....	37.72	2.60	42.93	.....	39.23	.....
May	54.38	.....	49.22	1.90	50.82	.....	50.00	.....
June	64.10	.....	59.89	3.21	62.71	.....	60.40	.....
July	69.50	.....	65.08	2.79	65.82	.....	68.20	.....
August	66.24	.....	64.72	3.02	64.78	.....	64.18	.....
September	64.26	.....	56.66	2.80	56.07	.....	58.78	.....
October	49.59	.....	45.00	2.68	47.15	.....	47.09	.....
November	35.23	.....	32.73	2.63	34.01	.....	36.75	.....
December	26.14	.....	22.13	2.12	26.37	.....	25.77	.....

Table showing the monthly averages of temperature and rainfall, &c.—Continued.

MICHIGAN.

Months.	Ontonagon.		Otsego.		Pleasanton.		Pontiac.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp	Rainfall.	Temp.	Rainfall.
January	16.41		27.95		21.79		21.49	
February	15.59		51.03		20.40		26.28	
March	21.80		34.99		25.56		34.09	
April	36.91		45.53		40.05		45.28	
May	48.26		54.34		55.16		57.47	
June	59.49		65.31		60.92		68.24	
July	64.89		70.32		66.51		68.81	
August	63.50		67.35		63.69		68.20	
September	55.98		61.99		58.44		56.98	
October	43.79		47.45		39.41		44.87	
November	33.25		40.83		30.47		36.77	
December	20.46		30.83		25.75		25.55	

Months.	Saint James.		Sault de St. Marie.		Tawas City.		Ypsilanti.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	20.36		19.45		21.56		24.42	1.41
February	15.48		18.55		23.67		26.73	1.72
March	24.64		27.90		30.20		34.19	3.29
April	39.04		40.45		39.80		44.56	3.29
May	50.35		49.90		50.75		58.16	3.00
June	59.65		60.70		62.03		65.30	3.05
July	66.53		64.90		67.49		70.03	1.78
August	66.55		62.90		66.68		68.95	3.65
September	59.60		55.60		58.88		58.81	4.03
October	47.87		42.60		48.06		48.62	2.72
November	35.48		30.70		36.89		37.61	2.70
December	24.76		22.95		25.91		28.10	2.23

WISCONSIN.

Months.	Bay City.		Bayfield.		Dartford.		Delafield.		Delavan.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	13.94	2.24	13.44		17.05		22.59	2.03	15.69	1.01
February	12.27	1.47	15.08		20.32		24.51	1.83	23.01	1.60
March	23.45	2.48	23.68		30.69		33.43	2.37	27.57	2.45
April	33.02	4.93	38.59		44.24		44.28	3.32	44.65	2.75
May	45.20	6.09	49.65		52.55		56.03	5.42	52.33	1.68
June	56.58	4.61	60.15		67.25		64.14	2.91	67.29	3.38
July	65.08	3.72	67.84		68.45		69.41	4.65	68.84	2.94
August	60.90	5.62	63.59		69.13		68.30	1.41	66.34	6.97
September	53.48	5.88	54.70		61.37		60.82	4.79	60.54	4.60
October	39.38	4.87	41.59		49.15		48.94	2.84	47.06	2.10
November	26.40	3.18	30.25		34.25		35.74	1.86	36.37	0.75
December	15.90	1.36	18.21		28.55		22.50	1.45	19.96	1.78

Months.	Embarrass.		Emerald Grove.		Green Bay.		Green Lake.		Holland.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	15.19	2.28	23.92		15.19		24.57		15.01	
February	20.78	1.22	26.48		23.00		27.22		23.49	
March	26.71	2.36	34.60		27.14		32.13		27.17	
April	40.58	1.92	42.50		39.77		40.37		43.58	
May	54.41	2.04	55.43		54.46		50.42		56.20	
June	65.19	4.11	67.39		66.36		67.48		63.93	
July	69.95	4.80	70.51		69.85		69.35		69.91	
August	65.32	4.38	68.57		68.09		67.33		67.67	
September	58.09	3.28	61.05		60.46		60.90		60.58	
October	44.56	2.85	48.07		45.85		49.16		44.61	
November	32.54	2.69	34.48		35.98		37.11		35.22	
December	18.77	2.15	19.19		17.66		20.35		23.05	

Table showing the monthly averages of temperature and rainfall, &c.—Continued.

WISCONSIN.

Months.	Kenosha.		Lowell.		Manitowoc.		Milwaukee.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	28. 86		5. 95	0. 30	21. 76	2. 02	21. 39	1. 88
February	26. 07		25. 84	3. 60	23. 92	1. 80	25. 22	1. 27
March	33. 06		27. 05	0. 75	31. 31	1. 84	32. 81	2. 41
April	40. 96		33. 86	2. 85	41. 72	2. 49	43. 36	3. 15
May	52. 40		53. 03	2. 70	51. 91	1. 89	52. 95	4. 29
June	63. 43		63. 04	2. 90	62. 04	3. 12	63. 60	2. 98
July	70. 51		69. 72	3. 10	67. 91	3. 97	69. 86	4. 79
August	68. 50		66. 81	5. 65	65. 95	4. 00	67. 61	3. 26
September	60. 94		62. 54	1. 80	58. 64	2. 52	60. 99	4. 65
October	49. 71		47. 80	3. 65	46. 95	2. 83	48. 78	3. 18
November	36. 46		29. 83	2. 05	36. 21	2. 07	37. 10	2. 16
December	26. 70		29. 67	0. 90	25. 48	1. 74	25. 38	1. 75

Months.	Mosinee.		Plymouth.		Superior.		Weyauwega.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	13. 24		16. 45	1. 30	11. 56	0. 95	15. 72	3. 72
February	17. 67		19. 94	1. 90	14. 17	1. 44	18. 83	0. 65
March	25. 38		25. 75	3. 40	22. 22	1. 45	27. 54	2. 85
April	45. 33		40. 54	3. 10	36. 76	2. 07	44. 25	2. 94
May	58. 60		51. 39	2. 20	47. 03	2. 62	56. 82	0. 94
June	66. 20		64. 67	4. 60	57. 53	2. 34	67. 70	6. 30
July	67. 80		69. 95	3. 95	64. 52	3. 15	70. 33	6. 20
August	62. 08		65. 72	5. 45	63. 70	3. 19	66. 51	5. 35
September	59. 13		58. 34	6. 60	53. 01	3. 66	62. 75	8. 63
October	44. 00		44. 08	3. 90	43. 15	2. 67	44. 78	5. 50
November	31. 75		34. 82	0. 85	30. 38	1. 31	32. 56	0. 10
December	16. 75		20. 77	1. 35	13. 74	0. 79	23. 42	1. 07

IOWA.

Months.	Guttenberg.		Months.	Guttenberg.	
	Temp.	Rain fall.		Temp.	Rain fall.
January	15. 87		July	66. 28	
February	20. 64		August	69. 90	
March	25. 88		September	64. 98	
April	44. 80		October	46. 56	
May	59. 33		November	34. 92	
June	68. 55		December	16. 77	

MINNESOTA.

Months.	Afton.		Beaver Bay.		Burlington.		Forest City.		Fort Ripley.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	11. 78		12. 87	2. 61	17. 57	1. 51	10. 18		7. 41	
February	14. 77		14. 37	0. 86	14. 25	1. 71	15. 60		11. 89	
March	20. 17		22. 36	1. 82	29. 86	2. 26	27. 87		23. 98	
April	42. 88		36. 22	2. 78	34. 86	2. 47	43. 36		40. 82	
May	56. 09		47. 02	3. 29	47. 09	6. 47	57. 06		54. 80	
June	66. 12		55. 92	2. 76	55. 91	4. 33	66. 40		65. 97	
July	70. 23		62. 03	2. 65	62. 52	5. 42	69. 08		70. 50	
August	66. 05		61. 62	3. 15	62. 04	4. 75	66. 89		66. 18	
September	59. 86		52. 76	3. 10	54. 38	3. 48	57. 83		56. 52	
October	42. 53		41. 56	2. 15	41. 63	4. 24	44. 79		44. 77	
November	32. 43		30. 96	1. 02	28. 69	2. 34	30. 21		28. 26	
December	14. 99		16. 32	1. 01	13. 34	1. 37	15. 47		11. 08	

Table showing the monthly averages of temperature and rainfall, &c.—Continued.

MINNESOTA.

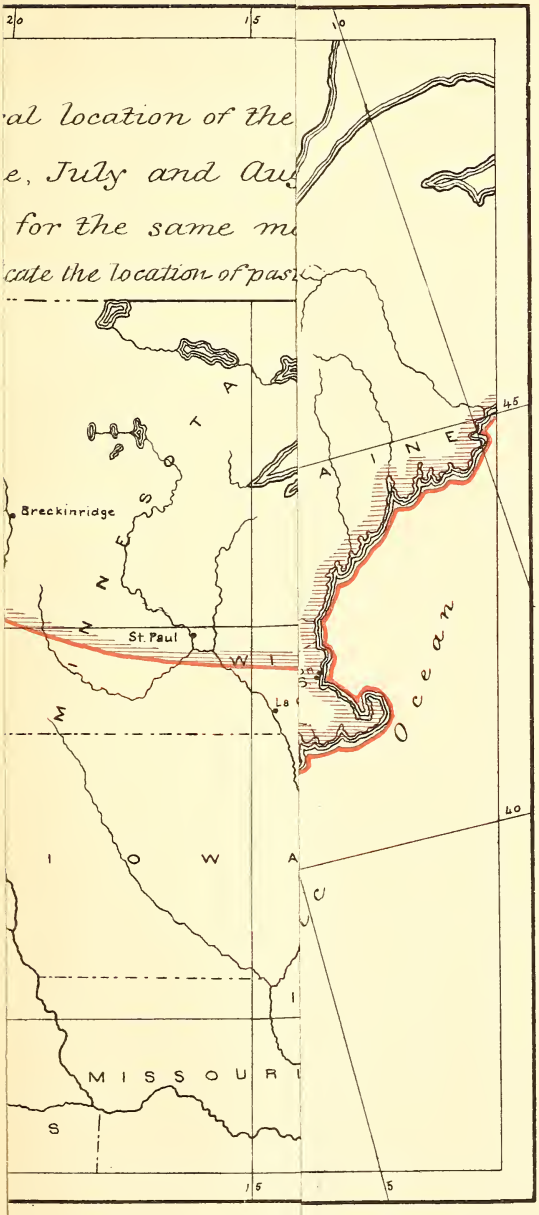
Months.	Hennepin County.		Koniska.		Saint Joseph.		Saint Paul.		Sandy Lake.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	11.60	.....	12.01	.....	—1.18	.....	11.37	0.93	13.93	.....
February	23.00	.....	13.17	.....	6.33	.....	16.94	0.72	17.08	.....
March	24.10	.....	25.21	.....	20.62	.....	23.06	1.67	29.68	.....
April	41.30	.....	43.38	.....	43.16	.....	43.04	1.98	38.23	.....
May	58.00	.....	57.12	.....	52.28	.....	57.47	1.93	50.15	.....
June	67.10	.....	63.15	.....	65.77	.....	66.65	3.40	60.94	.....
July	66.50	.....	68.24	.....	68.30	.....	70.64	3.93	67.69	.....
August	67.20	.....	62.58	.....	66.63	.....	66.81	3.78	65.47	.....
September	67.30	.....	57.58	.....	54.68	.....	58.30	1.88	58.10	.....
October	47.70	.....	40.07	.....	45.19	.....	44.09	2.31	43.36	.....
November	38.40	.....	30.40	.....	25.01	.....	32.55	1.27	22.83	.....
December	9.30	.....	16.86	.....	13.35	.....	16.96	1.19	9.70	.....

DAKOTA.

Months.	Fort Ransom.		Fort Totten.		Fort Wadsworth.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	6.98	.....	— 0.52	.....	5.21	.....
February	10.20	.....	7.41	.....	9.43	.....
March	16.42	.....	13.47	.....	10.96	.....
April	43.73	.....	46.19	.....	40.22	.....
May	59.07	.....	59.22	.....	55.33	.....
June	65.62	.....	67.52	.....	65.17	.....
July	70.34	.....	69.59	.....	70.39	.....
August	65.27	.....	65.82	.....	67.27	.....
September	57.41	.....	58.67	.....	58.99	.....
October	39.16	.....	38.33	.....	43.45	.....
November	28.03	.....	27.57	.....	30.40	.....
December	13.96	.....	12.48	.....	12.91	.....

CALIFORNIA.

Months.	Alcatraz Island.		Angel Island.		Benicia Barracks.		Camp Lincoln.		Fort Bragg.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	53.18	8.10	50.58	.....	47.43	2.65	45.70	26.23	47.69	.....
February	54.82	2.85	53.04	.....	50.94	2.00	46.49	11.29	47.17	.....
March	54.69	1.20	55.15	.....	53.93	2.53	48.03	4.59	49.11	.....
April	55.49	0.45	58.10	.....	58.34	1.58	54.92	10.06	50.19	.....
May	55.94	0.25	60.13	.....	60.92	0.65	58.11	0.60	54.36	.....
June	56.61	0.03	61.51	.....	66.47	0.13	57.75	1.12	57.98	.....
July	57.77	0.00	63.91	.....	67.78	0.03	62.02	0.05	59.64	.....
August	57.80	0.00	63.14	.....	66.75	0.02	58.82	0.00	57.34	.....
September	59.40	0.00	62.71	.....	66.18	0.09	58.35	0.75	57.81	.....
October	60.31	0.19	61.05	.....	63.32	0.46	55.47	1.34	54.13	.....
November	58.99	1.12	58.27	.....	55.27	1.80	51.54	10.17	49.56	.....
December	55.18	4.98	52.66	.....	47.88	3.11	49.33	15.39	49.27	.....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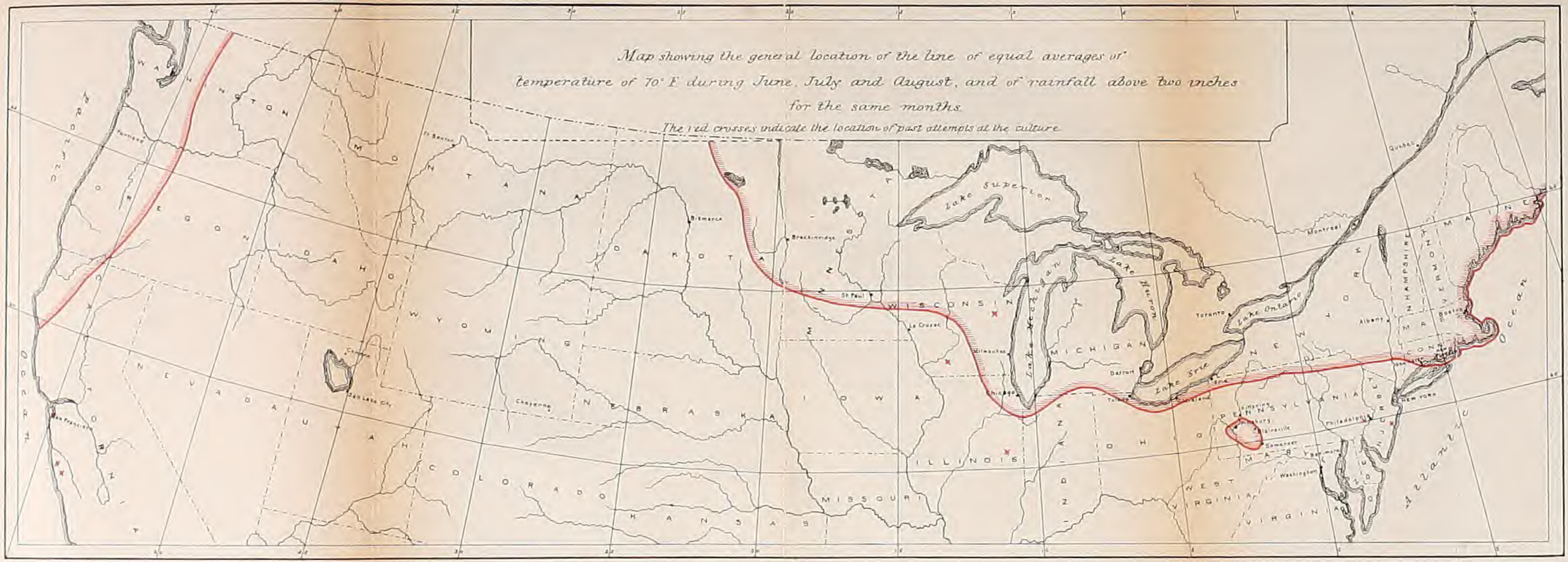

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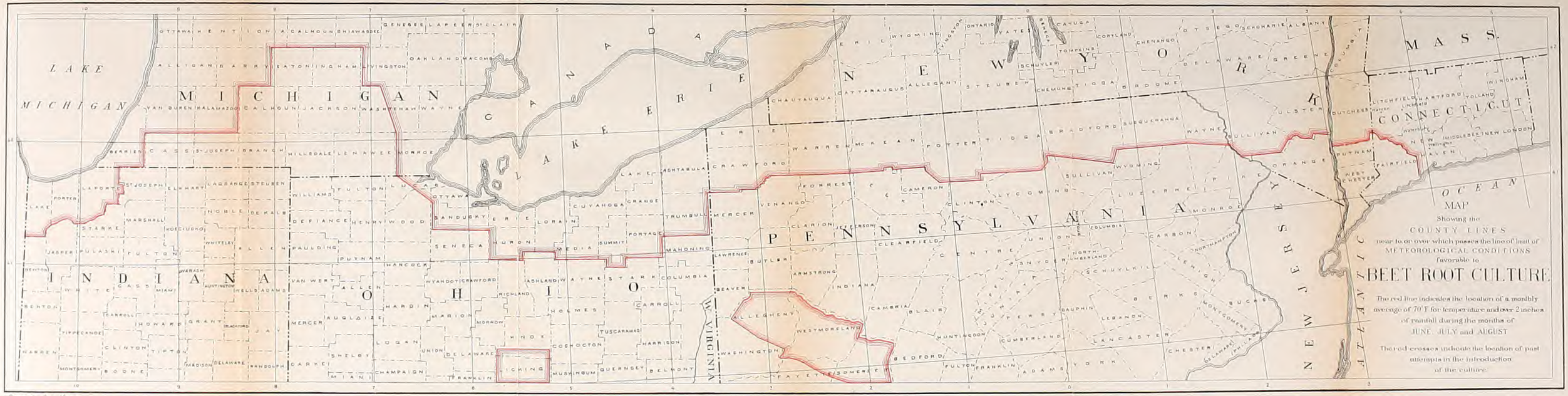

Drawn by Geo. Marx.

MAP
Showing the
COUNTY LINES
near to or over which passes the line of limit of
METEOROLOGICAL CONDITIONS
favorable to
BEET ROOT CULTURE

The red line indicates the location of a monthly average of 70° F for temperature and over 2 inches of rainfall during the months of JUNE, JULY and AUGUST

The red crosses indicate the location of past attempts in the introduction of the culture

MAP
OF THOSE PARTS OF
WASHINGTON TERRITORY
OREGON AND CALIFORNIA
WHERE THE
METEOROLOGICAL CONDITIONS
FAVOR THE CULTURE OF THE
SUGAR BEET
THE RED LINE INDICATES THE
EASTERN LIMIT

Table showing the monthly averages of temperature and rainfall, &c.—Continued.

CALIFORNIA.

Months.	Fort Humboldt.		Fort Point.		Fort Ross.		Fort Terwaw.		Meadow Valley.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	47.29	5.78	50.59	6.03	47.18	.....	43.72	9.97	32.54	7.41
February	47.55	5.96	51.81	3.10	48.04	.....	47.84	8.78	35.14	6.05
March	49.22	5.30	53.15	2.12	49.95	.....	49.15	4.50	41.09	6.21
April	51.84	2.82	55.52	1.50	51.26	.....	51.70	6.07	47.07	3.20
May	55.00	1.24	57.61	1.66	55.32	.....	54.35	3.63	53.04	1.98
June	58.20	0.47	58.93	0.00	56.90	.....	59.63	0.18	60.59	1.09
July	58.09	0.19	59.86	0.00	57.82	.....	59.79	2.41	66.97	2.40
August	58.15	0.07	58.84	0.00	58.39	.....	60.92	0.71	64.71	1.13
September	57.67	0.59	59.31	0.50	55.97	.....	59.92	3.81	59.08	1.53
October	54.05	1.78	58.36	0.27	53.42	.....	54.91	5.64	50.15	2.41
November	51.25	4.13	56.44	2.50	50.90	.....	50.41	12.71	40.57	12.10
December	46.17	7.59	52.22	9.00	48.91	.....	45.11	11.52	33.72	11.52

Months.	Monterey.		New San Diego.		Presidio.		San Francisco.		Yerba Buena Island.	
	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.	Temp.	Rainfall.
January	50.04	1.68	54.59	.....	49.69	.....	48.81	8.05	57.97	.....
February	50.35	1.50	56.01	.....	51.01	.....	50.81	4.44	52.17	.....
March	52.13	3.27	57.30	.....	52.34	.....	53.24	2.66	53.95	.....
April	54.56	0.63	60.86	.....	54.52	.....	55.24	1.59	55.85	.....
May	57.05	0.53	66.38	.....	55.37	.....	56.40	0.49	57.27	.....
June	58.67	0.13	67.57	.....	56.91	.....	57.90	0.05	58.38	.....
July	60.05	0.08	68.71	.....	57.62	.....	57.98	0.00	61.80	.....
August	60.47	0.00	70.90	.....	57.87	.....	58.24	0.03	60.79	.....
September	59.95	0.01	68.18	.....	59.13	.....	59.73	0.08	61.17	.....
October	57.94	0.33	65.16	.....	58.01	.....	58.82	0.39	61.02	.....
November	54.01	1.31	60.89	.....	54.70	.....	54.89	3.01	57.49	.....
December	50.14	2.72	53.30	.....	50.25	.....	50.66	5.80	50.46	.....

We see from this that the sections of the United States most favorable to beet-root culture are confined to the north, including New England, New York, a narrow band south of the lakes, Michigan, parts of Wisconsin, Minnesota, and Dakota. Here the line of the southern limit passes into the British possessions and enters the United States again in Washington Territory, and, crossing Western Oregon, passes to the coast to the extreme north of California. In most of this band we find a favorable temperature, and the average rainfall is sufficient in quantity, but we are unable to make any observations concerning the number of rainy days. In California, as the tables will show, the temperature is sufficiently moderate, but, from examination of the figures for the stations for which the rainfall has been recorded, we find it to be remarkably deficient. Here, in order to make the culture a success, it would appear that the intervention of irrigation during the summer months would be an absolute necessity.

We also note a few counties in the southwestern portion of Pennsylvania, and one county in Ohio, without the general band, where suitable meteorological conditions seem to exist. These counties are surrounded by the red line in the more detailed map that has been prepared, showing the county lines near to or over which the line of the limit of favorable meteorological conditions passes. This map is intended for more

ready reference for those who may contemplate establishing the culture in the sections in the near neighborhood of the line.

Now, I do not mean to assert that the band of country I have thus plotted on the map is exclusively that in which the introduction of beet-root culture may be attempted with prospects of success, but it is certain that within this band the chances of success are greater than they are without it, and it also appears that all the unsuccessful attempts* that have heretofore been made to establish the industry have been at points without it. It is therefore advisable that farmers or manufacturers who may design entering upon the prosecution of this industry should study with greatest care these influences which operate with so much benefit or injury upon the profit of the crop. It is evident from what precedes that the beet requires a cool or at least a moderate season for suitable progress in development, that it may not reach maturity in advance of the time for working it into sugar, and under the influence of the rains and elevated temperature of the autumn months enter into a second growth, thereby destroying the valuable constituents which renders it so desirable as a sugar-producing crop.

In this connection it has been suggested that in sections of protracted warm seasons, when the root will develop and attain full maturity in August, and during the summer drought, the crop could be taken up before the appearance of the autumn rains, and by slicing and drying the roots preserve them until the arrival of the proper season. This mode of procedure has in fact been recommended to the agriculturists of the south of France, and has, it has been stated, been the subject of experiment in Algeria. The method has the objection of being a rather precarious one on account of the chances of the crop being caught after a long-continued drought by late heavy summer showers that would prove almost as injurious as the autumn rains.†

After the directions given by Briem and others it is scarcely necessary to recapitulate here the meteorological conditions which appear to be required by this culture, yet the conclusions arrived at from our study of the subject, in addition, may not appear superfluous. The conditions, then, are in general, comparatively dry and warm spring months during the time for preparation of the soil, planting, and cultivating the crop; moderate temperature, abundant and frequent rains during the summer months, the time for ultimate development of the crop and its valuable constituents; cool dry fall, the time for ripening, harvesting, and storing the crop. If these conditions prevail, the results will be good; otherwise they will be but medium or even bad.

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*The locations of these attempts are indicated by a red cross in the detailed map.

†The experiment of drying beets for preservation in Maine, in the fall of 1878, proved quite disastrous financially for those who engaged in the enterprise.

CHAPTER IV.

VARIETIES OF BEETS GROWN IN FRANCE—THEIR CHARACTERS, MODE OF SELECTING, ETC.

The importance of the variety or race of the beet to be grown for sugar cannot be questioned. A beet giving a large cultural yield rich in sugar involves no more cost to the grower in its production than one giving a small yield and low saccharine value. It is therefore useful to choose those which will give the greatest returns and be at the same time the most satisfactory in every way to the grower who must produce them and to the manufacturer who must extract the sugar.

For the latter it is admitted that the raw material—the juice of which contains the smallest percentage of mineral and organic impurities, other things being equal—will give a larger yield of sugar than juices in which these constituents exist in larger proportions, and it is well known and generally understood that these favorable conditions are found in roots of moderate size more frequently than in large ones. Thus Briem* says, "The size of the beet is in the inverse ratio of its content of sugar and salts; the content of water increases with the size and weight of the beet"; and Champion and Pellet state† that beets of good quality generally have an average weight of 700 to 800 grams ($1\frac{1}{2}$ to $1\frac{3}{4}$ pounds), and this size seems to be generally adopted as the most favorable by the best authorities on beet culture in France and by the manufacturers almost unanimously.

The rule that the smaller the beet the richer in sugar appears to find illustration if not complete confirmation in the results of examination of the beets submitted by Professor Deherain‡ to experiment at the college farm at Grignon, and produced from seed furnished by Vilmorin, Andrieux & Co.

Number.	Improved exposition beets.		Improved beets No. 848.		Pink top beets, Verrières.		Pink top No. 34.	
	Weight of beet.	Per cent. of sugar in juice.	Weight.	Per cent. of sugar in juice.	Weight.	Per cent. of sugar in juice.	Weight.	Per cent. of sugar in juice.
	Grams.		*Grams.*		*Grams.*		*Grams.*	
1	395	18.1	282	20.0	980	13.10	530	13.75
2	365	16.7	330	20.0	460	12.05	622	13.10
3	720	16.4	660	18.8	630	11.30	837	12.50
4	600	15.6	450	18.7	627	10.00	1,115	11.25
5	620	15.0	385	18.4	890	9.84	1,040	10.60
6	740	13.9	335	18.4	1,150	9.20	....	.....
7	1,130	13.4	560	17.7	.....	.....	.....	.....
8	850	13.2	580	16.9	.....	.....	.....	.....
Averages ..	677	15.5	447	18.6	789	10.91	828	12.24

* Journal des Fabricants de Sucre, October 23, 1878.

† *La Betterave à Sucre*, p. 98. ‡ *Annales Agronomiques.*

The form of the beet seems also to be an important feature in the consideration of the proportion of sugar to be obtained, and Champion and Pellet further state,* concerning beets of good quality, "their form is elongated and tapering." This admits of more thorough penetration of the root in the soil, more complete contact with the nutritive elements, moisture, &c., insures the plant against variations of existing conditions, and consequently a healthier state, from which must naturally follow a better quality.

Corenwinder and Contamine † find that there is a relation between the size of the leaves and the richness of the roots; that roots which bear leaves of broad surface are generally more rich in sugar than those having small leaves upon a contracted top, and these facts are confirmed by analyses of subjects taken from the same field. At the same time Deherain concludes from his researches ‡ that the weight of leaves of small beets is relatively greater than is produced by larger ones. The relations found are as follows:

Variety of beets.	Weight of leaves.	Weight of roots.	Sugar in 100 of juice.
	Grams.	*Grams.*	
Pink top O	281	1,393	9.94
Pink top Enterré	375	984	10.18
Improved 1,093	531	863	14.42
Improved 927	531	787	14.78

In connection with this relation between the size and richness of the sugar beet and the number and weight of leaves they bear Champion and Pellet § give the following figures:

Variety of beets.	Pounds of leaves per 100 of roots.	Per cent. of sugar in beet.
Improved Vilmorin	56	14.5
Simon Legrand (choice)	33	13.3
Ordinary of sugar factories	20	11.8

Beets produced in special cultures.

Variety.	Roots.	Leaves.	Per cent. of sugar.
	Pounds.	*Pounds.*	
Ordinary seed, special culture	100	52	13.2
Ordinary seed, ordinary culture	100	28	11.8

* *La Bettrave à Sucre.*

† *Annales Agronomiques*, t. IV, 380.

‡ *Ib., t. III*, 98.

§ *La Bettrave à Sucre.*

Other tests gave—

Percentage of sugar in roots:	Weight of leaves per 100 pounds.
15.4	58
15.2	63
14.1	52
14.7	62
13.1	31
13.8	26
13.5	36
12.4	25
11.8	26

These are the principal external characteristics which seem to have an influence upon the composition and value of the beet, and for the description of the varieties finding greater favor in France and most extensively grown we shall quote from the writing of Mons. H. Vilmorin.

It is generally admitted that the saccharine richness of beets is inversely proportional to their volume. Taken in a general way this proposition expresses a truth, but it is certain that selection judiciously applied may cause a variation of this relation, and enrich a given race of beets without diminishing either the volume or the yield. It is in modifications of this kind that we should seek the practical improvement of the beet, and the end proposed is to create, at different degrees of the scale, races of beets uniting with a given yield the maximum saccharine richness compatible with that yield.

The search for a beet which shows at the same time a maximum of product and a maximum of richness is a chimera, and the sooner its pursuit is relinquished the more will disappointment and useless endeavor be avoided. In fact, high saccharine richness is necessarily allied to a great abundance of leaves and rootlets, and beets rich in rootlets and leaves cannot become voluminous without becoming deformed and losing the external qualities of regularity and cleanliness which are in a great measure indispensable to a good race of sugar beets.

Starting out, therefore, with the idea that the different circumstances in which the manufacturer or the grower finds himself placed demand different beets, let us examine the really known varieties and what they may become under the influence of skilfully applied selection.

The White Silesian sugar beet (Fig. 1), origin and point of departure of all the other varieties, is still preferred above all in a large part of Europe. It is a race of medium size, almost entirely buried, with white skin, slightly wrinkled, leaves rather spreading than erect. It is rich in sugar, generally containing 12 to 14 per cent. Its yield in good conditions is about 20 tons per acre. It is perfectly adapted to close culture, and does not require very deep soils. Cultivated in France for some years, it has increased in volume, and has come to yield easily 22 to 23 tons per acre. Now that there is a tendency to return to beets rich in sugar, the *acclimated white German* beet is one of the varieties most recommended.

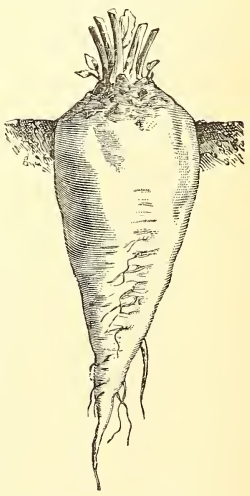

FIG. 1.—*White Silesian Beet.*

Of this there exist several sub-varieties, obtained by selection. We cite among the most distinct the *Magdeburg*, rather small, but long and very regular; the *Breslau*, shorter and more swollen; the *Imperial* beet (Fig. 2), obtained by Knauer, which is long, regularly tapering, having the form of a carrot, foliage light-

colored, curly, and approaching the ground; the *Electoral*, of the same origin, more (gonflée) swollen, larger, and more productive, but slightly less rich than the *Imperial*.

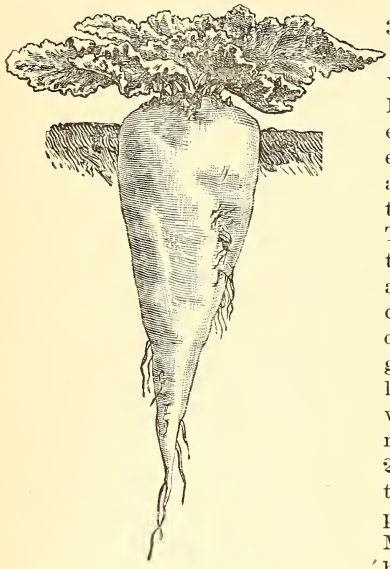

FIG. 2.—*Imperial Beet.*

The *green-top* sugar beet, a French race (Fig. 3), is in much less favor to-day than it was fifteen years ago. It is, however, an excellent race, larger, better formed, and smoother than the Silesian beet. The top, which protrudes from the earth a few centimeters (a couple of inches) only, is colored green; the root is long, smooth, and white. This variety may give as high as 25 tons per acre, containing from 11 to 14 per cent. of sugar. Manufacturers who have continued to cultivate it have had reason to be satisfied with it. We have known its yield in sugar to be as high as 3.69 tons of 2,000 pounds per acre.

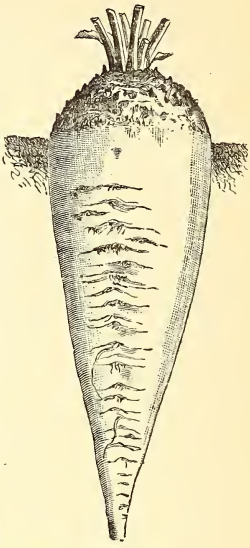

FIG. 3.—*Green-top Beet.*

The French *pink-top* beet (Fig. 4) is that which has been most generally grown for years. The favor accorded it is justified by a collection of qualities which seem to make the race the most advantageous of all, in the ordinary conditions of the culture of our country. In fact it unites great vigor, which admits of its yielding 28 to 30 tons per acre, with a generally regular form and a very satisfactory richness, which varies from 10 to 13 per cent. of sugar; it is at the same time capable of easy preservation. The foliage is vigorous and abundant, and the top protrudes slightly from the ground in such a way as to facilitate pulling without diminishing the saccharine quality of the root. The largest yields per acre we have ever known have been obtained with this variety. We have known a production of 3.95 tons of sugar per acre.

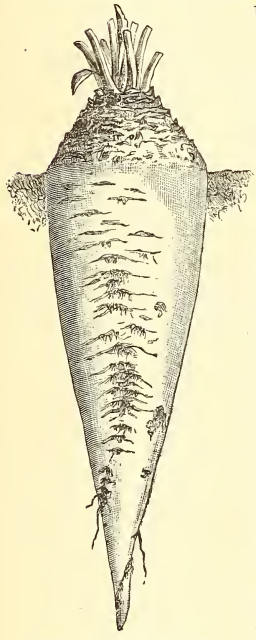

FIG. 4.—*Pink-top Beet.*

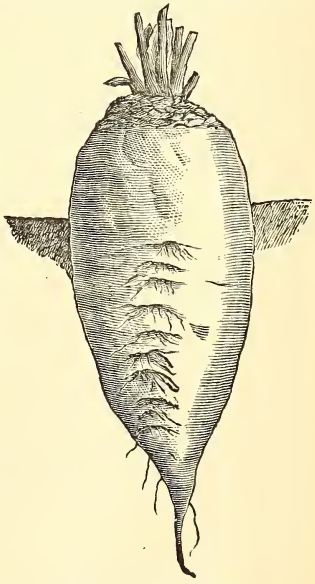

FIG. 5.—*Gray-top Beet.*

The *gray-top* beet or the *pinkish gray* beet of the North (Fig. 5), is of all others the

most perfect as to form and the most productive. It has but few leaves, and very nearly one-fourth the length of the root is above ground. This part is gray, greenish, or brown; is clean and smooth like the buried portion, which is more or less pink. On the other hand it is the least rich of all the sugar beets, and is at present almost universally proscribed by manufacturers. We believe the sentence rather severe, because the gray-top beet is capable of giving, by means of a suitable culture, yields of sugar per acre which rival those of other races, and we believe it may be sufficiently improved with regard to the richness without losing its qualities of form and volume.

The white improved Vilmorin beet (Fig. 6) descended directly from the white Silesian, was brought by Mons. L. Vilmorin, by means of selection, to present, after several generations, a richness of 15 to 18 per cent. of sugar. This has been its condition for long years, and experience proves that it would be chimerical to endeavor to obtain greater richness, because the plant would then cease to grow with sufficient force. Efforts have tended in these latter years toward the improvement of the form and increase of the product, and important progress has been realized in this direction, since the improved beet, which was represented at the beginning as giving per acre a product of 8 to 10 tons, containing 15 to 16 per cent. of sugar, has given in late yields of 18 to 20 tons per acre with a richness in sugar varying from 15 to 18 per cent.

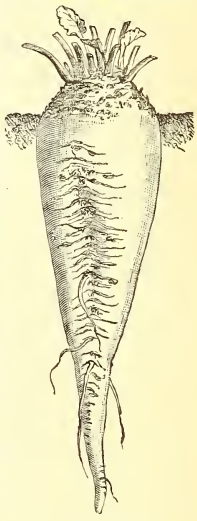

FIG. 6.—*Vilmorin's Improved Beet.*

This race has always been considered particularly suited to special conditions of culture and manufacture which are not those of France; it seems to us, however, that, in consequence of the modifications to which it has been submitted in later times, and which have increased its volume and its yield, it may be adopted in certain cases, even in our country. By growing it very closely, the inferiority of its volume as compared with that of other races is in great part compensated for, and on the other hand it has been proven by numerous analyses, especially in the competitive exhibitions of beets at Arras and Senlis, that this race surpassed all others, not only in saccharine richness, but also in the purity of its juice, which contained less of ashes and salts than that of any other variety, an advantage of very great importance.

This brings us to the consideration of the internal structure and composition of the beet, which, like the external characteristics, may naturally be modified by the conditions of culture and nutrition to which the plant is subjected.

The structure of the root has been the subject of careful study by M. Decaisne, the able director of the Department of Vegetable Physiology of the *Jardin des Plantes* at Paris, and he has made a complete microscopic examination and consequent description of the minute anatomy, but in this report we shall notice only those physical characters which are manifest to ordinary vision, and the relations they bear to the economic value of the root. It is this part of the subject that has been worked up by Payen, who called attention to the appearance of the alternate opaque and transparent bands when the root is sliced in the direction of its longer axis, and of similar zones when cut in the direction of its shorter axis. Of these, he shows that the former or opaque zones are the richer in sugar, and in his memoir on this subject he says:*

**Compte rendus*, xxiv, 909. Quoted in Traité de la Fabrication du Sucre, by E. J. Maumené, t. I.

If a root be cut in the direction of its length and through its center, it shows the section represented in Fig. 7. *b b b* are the parts containing the sugar. They are distinguished by their more decided white appearance; all the tissue which separates them is grayish, and contains little or no sugar. This is proven by chemical tests, by cupric liquor among others, or even simply by the taste.

Champion and Pellet state * that—

If very thin slices of pink beets be used, after a few minutes' exposure to the air, the zones pointed out by Payen may each be subdivided into two different zones, separated from each other by a series of black points (tubes) distributed in the form of circles, and seeming to correspond with the leaves.

The structure would then be as follows: 1, opaque zone; 2, transparent zone; 3, opaque zone; 4, zones of vascular tissue.

The formation of these zones seems to be in some way allied to the production of leaves, as well as the increased proportion of sugar contained in them, for Bretschneider noticed a relation between the number of leaves and of the concentric layers, and Gaudichaud found that "the leaves of beets correspond directly with the different zones of vessels in the roots in such a way that the appearance of new leaves should always give rise to new zones of vessels"; while in connection with the above facts Champion and Pellet give the following figures, showing the relation between the percentage of sugar in the juice, the number of leaves on the plant, and the number of zones in the root:

Seed used.	Sugar per cent. per volume.	Number of leaves on roof.	Number of zones.
Vilmorin seed	15.7	42	48
	14.8	39	36
	13.8	31	32
Ordinary seed of the factories	12.2	23	28
	11.5	19	20

Payen's notions found support in the results of examinations of the parts made by Joulie, Violette, and others. Notwithstanding the earlier statements of Violette, he has published results of analyses showing that the percentage of sugar in the several parts varies inversely with the distance of the part from the longitudinal axis, and that the higher percentage is found in the opaque zones. Thus the same beet gave the following figures:

	Per cent.
Translucid zones	14.5
	13.4
	10.0
Opaque zones	15.7
	15.5
	11.2

In his earlier work, Violette found little difference in the quantity of sugar present in the two kinds of tissue, but the notions then obtained

* *La Betterave à Sucre*, p. 58.

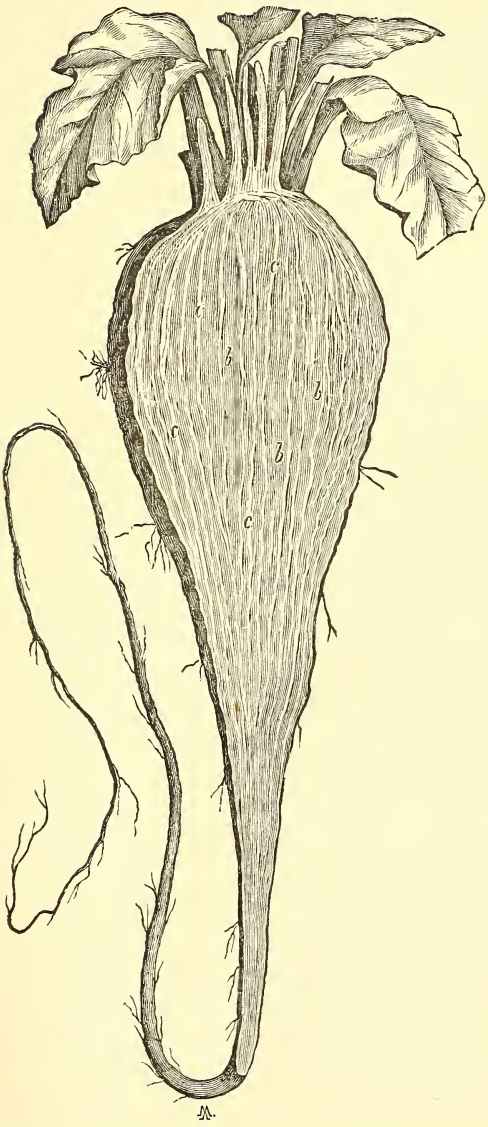

FIG. 7.—Vertical section of beet root to show anatomical structure.

from it with reference to the location of albuminoids and salts have received full confirmation in his own later work and in that of Professor Joulie. Thus, he stated—

> The former (the translucid zone) appears to contain the higher proportion of mineral matters. The proportion of chlorides may be eight times as great; organic, nitric, and phosphoric acids are about equivalent, but sulphuric acid is much more abundant in the sacchariferous tissue, probably on account of the predominance of the albuminoids.

The distribution of the albuminous matters and salts is shown in the following statement giving the composition of the translucid and opaque zones:

Zones.	Sugar.	Ash.	Saline quotient.	Nitrogen per cent. of normal matter.	Nitrogenous matters per cent. of normal matters.	Nitrogenous matters per 100 of sugar.
Opaque zones	11.27	0.63	5.5	0.263	1.643	14.5
Translucid zones	10.00	0.84	8.4	0.230	1.430	14.3

Violette also found a higher percentage of sugar in the lower portions than in the upper portions of the root, and Joulie found that the tops contained less of nitrogen than the lower extremities. Thus Violette, cutting the root in several slices, beginning at the top, found them to contain, respectively, of sugar the following percentages:

	Per cent. of sugar.
First slice	10.42
Second slice	10.54
Third slice	10.70
Fourth slice	10.80
Fifth slice	10.94
Sixth slice	11.11
Seventh slice	11.33

And Joulie found:

	Percentage of nitrogen in normal matter.	
Tops	0.30	0.295
Extremities of roots	0.33	0.260

The relation between the nitrogen and the sugar content of beets has been completely confirmed by the further results obtained by Professor Joulie in the analysis of beets grown under different conditions, as illustrated in the following table:

	Richness of beets in sugar.	Per cent. of nitrogen in beets.
From plots having received no nitrogen	12.55	0.264
	13.58	0.308
	15.24	0.515
Plots having received 57 pounds nitrogen per acre	11.06	0.352
	11.59	0.387
	12.97	0.429
	14.98	0.472

This relation exists not only in the structure of the root, but also in the juice after its extraction.

Relation between content of nitrogen in the beets and in the juice.

Per cent. of sugar in beet.	Parts of sugar in 100 of juice.	Parts of nitrogen for 100 of beets.	Parts of nitrogen for 100 of juice.	Nitrogenous matters for 100 of juice.
14.4	16.0	0.45	.....	.....
13.9	15.5	0.37	0.29	1.88
13.9	15.5	0.45	0.21	1.33
12.4	13.7	0.30	0.24	1.56
11.0	12.2	0.30	.....	.....
10.4	11.5	0.19	.....	.....
9.7	10.5	0.17	0.12	0.78

Or, calculated for 100 of sugar contained in root or juice:

Sugar per 100 grams of root.	Nitrogen per 100 grams sugar in root.	Parts sugar per 100 of juice.	Parts nitrogen per 100 sugar in state of juice.
13.9	2.6	15.5	1.8
13.9	2.9	15.5	1.3
12.4	2.4	13.7	1.6
9.7	1.7	10.5	1.1

The mineral matters, it appears from the above analyses by Violette, exist in larger quantities in those portions of the root which contain the higher percentages of sugar, but this relation does not appear to hold for entire roots—that is, comparative estimations of sugar and ash in different roots does not seem to establish a lower percentage of ash in roots containing tolerably high percentages of sugar, and that for roots varying in saccharine richness of from 10 to 14 per cent. the proportion of mineral matters present will not vary widely from 0.90 per cent., and this view is supported by the figures given by Champion and Pellet.*

Sugar in beet.	Ash in beet.	Relation of ash to sugar, 100 to—
Per cent.	*Per cent.*	
14.4	1.05	7.2
13.6	1.13	8.2
13.3	0.95	7.1
13.1	0.93	7.2
12.7	1.06	8.2
12.0	0.94	7.8
11.8	0.90	7.6
11.2	0.93	8.2
11.0	0.77	7.0
10.6	1.10	8.1
10.4	0.74	7.1
Average	.....	7.6

* *La Betrave à Sucre.*

But this latter relation will not hold good for the juice after extraction, as appears from the following table:

Richness of juice.	Ash per 100 volumes of juice.	Ash compared with 100 of sugar or saline quotient.
16.2	0.78	4.7
14.9	0.81	4.8
14.7	0.73	5.3
14.2	0.78	5.4
13.4	0.77	5.9
13.2	0.75	6.2
12.5	0.77	6.1
12.2	0.79	6.1
11.8	0.76	6.5
11.7	0.79	6.8
11.5	0.80	6.9
10.7	0.73	12.3
9.9	0.72	14.5
9.7	0.71	15.6
8.0	0.76	12.2

This question of the mineral constituents of the root, and the influence they exert upon the production of sugar and its extraction from the root, is an exceedingly important one and merits careful study. In this report it will be further discussed in the consideration of the fertilizers suitable to the crop, and the time and manner of their application. It is, however, proper to state further here, that, of the mineral matters present in the root, phosphoric acid and the alkalies, which are the most important mineral constituents of artificial fertilizers, that have the most beneficial influence upon the value of the crop, seem in the root to vary with the richness in sugar, the phosphoric acid increasing with an increase of the sugar content, and the alkalies decreasing under like conditions. These facts are fully established in the results of the researches of Professor Joulie, shown below:

	Sugar in root, per cent.	Per cent. of phosphoric acid in normal matter.
No. 1. Plot having received no phosphoric acid	12.97	0.042
	13.01	0.039
	14.98	0.054
No. 2. Plot having received, per acre, 58 pounds phosphoric acid	11.06	0.042
	11.45	0.048
	11.59	0.060
	12.52	0.071
No. 3. Plot having received 116 pounds phosphoric acid per acre	11.00	0.053
	13.24	0.086

	Sugar in root, per cent.	Percentage of potash and soda in normal matter.
Plots having received no alkalies	13.58	0.640
	14.98	0.415
	15.24	0.385
Plots having received 150 pounds of alkalies per acre	11.45	0.494
	11.54	0.480
	13.11	0.291

But the quantities of alkalies absorbed by the root seem never to exceed a certain limit, as shown by Peligot, Corenwinder, Pagnoul, and Leloup, and it is by no means proportional to the quantities supplied by the soil, and the quantity of sulphuric acid necessary to saturate or combine with the alkalies contained in the ashes of beets will not vary much from 58.5 per cent. their weight. This latter relation has been fully established by the work of Dubrunfaut, Corinwinder, Ragot, Champion and Pellet, and others.

Not only is the quantity of alkalies that may be absorbed by beets thus limited, but Champion and Pellet have found that the alkalies and alkaline earths, in the absence of those best suited to the plant, may substitute each other in the proportion of their respective chemical equivalents, a fact of importance in the study of the chemistry of soils and fertilizers.

Of all the qualities of the root, there is none that would afford as ready and easily applicable a means of separating beets of different quality as the density, and this has long been and still is considered by many growers a strong indication of the saccharine value, but the best authorities seem to consider it a doubtful one. Dubrunfaut finds this relation to be materially modified by the presence of air or gases in the root. This view is also held by Champonnois, who, in examining roots produced in the campaign of 1874 to 1875, found that a beet having a density of 1.010 may give a juice having a density of 1.050. The figures given by Champion and Pellet are also adverse to the idea. Examination of 12 beets gave the following:

	Density of roots.	Density of juice.
Four samples	1.012	1.043
Two samples	1.020	1.048
Two samples	1.026	1.052
One sample	1.031	1.050
Two samples	1.033	1.048
One sample	1.038	1.052

Other tests gave:

Density of root.	Density of juice.	Per cent. of sugar in juice.
1.033—1.030	1.058	11.7
1.025	1.056	12.2
1.025	1.052	11.3

Having now studied the internal structure and characters of the beet, and the conditions residing within the root itself, we come to the consideration of the juice, the quantity that may be extracted, and its composition and value. I do not propose to discuss the complete analyses of the juices, but to call attention to some of the later facts that have been worked out concerning the qualities which may affect the value or

may aid in determining it. We have seen above that the deposition of sugar in the roots is almost always accompanied by a proportional deposition of albuminoids and salts, and also that the relation found to exist in the root is continued in the juice after extraction. These conditions have an influence upon the separation of the sugar which the experience of the manufacturer has taught him is unfavorable, and they will be called up again in the treatment of the subject of manufacturing processes, but in the present section we desire to call attention more particularly to the quantity of juice that may be extracted, the conditions which may modify it, and the density of the juice as influenced by the proportion of sugar present.

Concerning the quantity of juice that may be extracted from roots, much will, of course, depend upon the method employed for the purpose, though it is also modified by the character of the roots to be treated. It is a well-known fact that rich beets will yield less of juice than poorer ones, a quality governed to some extent probably by the more dense character of the sacchariferous tissue, which is consequently more resistant to the rasps in the former than in the latter kinds of product.

Dubrunfaut, by observations upon beets grown by Decrombecque, arrived at the following figures for the quantities of pulp left from treatment of roots of different degrees of richness:

Richness of beet.	Percent of pulp given.
9 to 10 per cent.	18 to 20
11 to 12 per cent.	23 to 25
13 to 14 per cent.	26 to 27

Advocates of various systems of presses claim better results, but these figures may be accepted as a fair average of the work done on a large scale, with the ordinary methods of rasping and pressing now in use.

For the determination of the value of the juice after its extraction various methods are employed, and it would seem of value to call attention to them just here, since they must be used in the work the description of which must follow this. The methods which have found practical application and are most convenient for industrial purposes for estimating the sugar in juices are respectively based upon the density of the juice, the influence of solutions of sugar upon the variation of the plane of polarization of a ray of light passing through Nichols prisms, and the amount of cupric oxide which may be reduced to cuprous oxide by a given quantity of sugar. For the present purpose the estimation of sugar alone, simply for the determination of the value of the juice and consequently of the roots, will suffice for all requirements in the work of selection of roots or any matters arising in the commercial relations between the grower and manufacturer.

Complete analyses are needed only in the manufacturing process which must always be directed by a practical chemist for whom such details would here be superfluous. Determinations by the first method

may be effected by the use of the ordinary hydrometer, the scale of which registers specific gravities of from 1,030 to 1,100, or the comparison of the weight of a metallic body taken in the air and immersed in the juice may be employed.

By the first the instrument is immersed in the juice and allowed to float until it becomes stable, the mark on the stem to which it descends is noted, and the corresponding figure taken to learn the percentage of sugar present. The figure thus obtained must be multiplied by the coefficients given in the following table, published by Champion and Pellet,* or the figures given in the subsequent table and corresponding with the density found may be taken to save calculation:

Density.	Degrees Baumé.	Coefficients.		Average.
		According to Durin.	According to Champion and Pellet.	
	° °			
1.040 to 1.045	4.0 to 4.5	1.74	1.72	1.73
1.055 to 1.050	4.5 to 5.0	1.99	1.84	1.91
1.050 to 1.055	5.0 to 5.5	2.03	2.00	2.02
1.055 to 1.060	5.5 to 6.0	2.08	2.08	2.08
1.060 to 1.070	6.0 to 7.0	2.15	2.12	2.13
1.070 and above	7 and above		2.15	2.15
1.080 and above	8 and above		2.31	2.31

Be means of the average coefficients, the following table was constructed:

Density.	Per cent. of sugar.	Density.	Per cent. of sugar.	Density.	Per cent. of sugar.	Density.	Per cent. of sugar.	Density.	Per cent. of sugar.	Density.	Per cent. of sugar.
1.035	6.0	1.045	8.5	1.055	11.2	1.065	13.8	1.074	16.2	1.083	18.7
1.036	6.2	1.046	8.8	1.056	11.5	1.066	14.1	1.075	16.5	1.084	19.0
1.037	6.4	1.047	9.0	1.057	11.8	1.067	14.3	1.076	16.8	1.085	19.3
1.038	6.6	1.048	9.3	1.058	12.0	1.068	14.5	1.077	17.0	1.086	19.6
1.038	6.8	1.049	9.5	1.059	12.3	1.069	14.7	1.078	17.3	1.087	20.0
1.040	7.0	1.050	9.7	1.060	12.5	1.070	15.0	1.079	17.5	1.088	20.3
1.041	7.3	1.051	10.0	1.061	12.8	1.071	15.3	1.080	17.7	1.089	20.7
1.042	7.6	1.052	10.3	1.062	13.1	1.072	15.6	1.081	18.0	1.090	21.0
1.043	7.9	1.053	10.6	1.063	13.3	1.073	15.9	1.082	18.3	1.091	21.5
1.044	8.2	1.054	10.9	1.064	13.6						

These figures are determined for a temperature at 40° F., and are sufficiently exact for all practical purposes. They are modified, however, by certain circumstances of culture, such as the nature of the soil and fertilizers, and the humidity of the year. It is also a fact that in the juice of unripe beets the relation of the density and sugar percentage varies from the relations given above.

* *La Bettrave à Sucre.*

Corrections for temperature are given by Champion and Pellet as follows:

Temperature, Fahrenheit.	For densities between 1.000 and 1.100, add to the corresponding sugar percentage.
60°	0.05
70°	0.06
80°	0.08
90°	0.10

The method of determining the value of sacchariferous juices by means of the specific gravity is that which will find widest application and give the most satisfactory results in all hands outside the laboratory. The second method mentioned, which is to some extent mechanical in its application, and that may be used with limited laboratory appliances, though more complicated than the first, is that depending upon the rotary power of sugar solutions, or their power to influence the rotation of the plane of polarization of a ray of light passing through the Nichols prisms. It must be manipulated with care, however, and gives best results in practiced hands. The principal objection to the method is the costliness of the apparatus, but its convenience and practical accuracy cannot be questioned. Without entering further into a description of the principles of the method, or of all of the forms of apparatus which have been devised for the determination of sugar by this means, which may be found in any of the leading works on chemistry, I will merely call attention to the instrument lately devised by Laurent, of Paris, which finds such favor with all the chemists and manufacturers who have frequent occasion to estimate sugar in solutions, and who are discarding other polariscopes on account of its many advantages.

Laurent's instrument is a modification of that of Soleil. The difference consists in the introduction between the polarizer and analyzer of a plate of gypsum or selenite of such thickness as to give to the ray of light passing through the instrument a yellow tint identical with that of the line D of the sodium spectrum. The plate covers half the field of vision, so that the other half of the field, when white light is employed, will have the color complementary to yellow or violet blue. The difficulty of differences of appreciation of shades of color by observers is obviated by using the monochromatic light produced by introduction of a sodium salt into the colorless flame of the Bunsen burner. The slight blue shade of the Bunsen flame, which is decomposed by the spectroscope into violet and green, is disposed of by causing the light from the flame to pass through a solution of bichromate of potassium, which has the well-known property of absorbing the green, blue, and violet rays. The Selenite plate takes the place of the quartz prisms of the Soleil instrument, and the analyzer is connected with a metallic circular disc, which is arranged perpendicular to the axis of the instrument. The

upper edge of the disc is provided with two sets of divisions, one to indicate degrees of the circle, and another to indicate hundredths of sugar in the solution. This provision renders it possible to use the instrument for ordinary polariscopic work other than the determination of sugar, while the second admits of reading percentages of sugar without the otherwise necessary calculations. The plate is also provided with a vernier to assist in reading parts of divisions, and to the vernier is attached by an arm a magnifying glass to facilitate reading the indications, and a mirror, so arranged as to reflect the light from the lamp used upon the disc, thus obviating the necessity for an accessory light. There is also a special arrangement for so turning the Nichols prisms as to adjust them before taking observations, as well as to secure the maximum intensity of light when working with colored solutions, thus avoiding the decoloration of many solutions before observation that would otherwise be absolutely necessary. There are other ingenious mechanical appliances connected with the instrument which increase its usefulness, but for the further description of the instrument we must refer the reader to Maumene's *Traité de la Fabrication du Sucre*, or to the descriptive circular of the inventor and manufacturer, whose address is No. 25, rue de l'Odeon, Paris.

The other method for estimating sugar in solutions referred to is that depending upon the reduction of cupric oxide to cuprous oxide, and is based upon the use of modifications of the well known Tromner's or Fehling's solution. The formula more lately employed is that given by Violette, and is as follows:

Prepare a solution composed of 36.46 grams pure crystallized sulphate of copper and 140 cubic centimeters of distilled water. Then a second solution containing 200 grams pure crystallized Rochelle salts and 500 cubic centimeters of solution of caustic soda at 24° B. or 1.199 specific gravity.

When the solution of the two salts is completed (it may be hastened by means of heat if necessary) the first is carefully poured into the second, interrupting the operation from time to time to agitate the mixture in order to dissolve the precipitate which forms. The transfer is completed by washing the vessel which contained the first solution with distilled water. The mixture is then allowed to cool to 60° F. and the volume is increased to 1 liter.

One cubic centimeter of the solution thus prepared corresponds to 0.005 gram of cane sugar. Vogel proposed substitution of glycerine for Rochelle salt to render the solution more stable and prevent the gradual deposition of cuprous oxide, but this does not seem in all hands to have proven effectual. Pellet claims to have devised a thoroughly stable solution which he prepares by the following formula, substituting sodic carbonate for sodic hydrate, and adding a small quantity of ammonic chloride. It has the merit of being easily prepared. It is a modification of those of Fehling, Violette, Possoz, and others. He uses alkaline

carbonate after Possoz and ammonic chloride after Monier, the latter to give stability to the liquor.

The liquor is made up as follows:

Take

	Grams.
Pure crystallized sulphate of copper	68.7
Rochelle salt	200.
Dry pure carbonate of soda	100.
Chloride of ammonium	6.87

Mix with 500 or 600 cubic centimeters of water; dissolve with heat on a water-bath, cool and make up to one liter; filter if necessary. The standard of the liquor is 10cc=0.65 gram of sugar, but this should always be verified. Pellet found in using the liquor that the results varied with the volume employed, but is exact for the following volumes of fluid:

	Cubic* centimeters.
Cupric liquor	30
Sugar solution with or without water	20

In its application the copper liquor is mixed with the sugar solution, and the whole heated upon the water-bath for half an hour; the precipitate is collected upon a filter, washed, the suboxide of copper dissolved in hot dilute chlorhydric acid, oxidized by chlorate of potash or permanganate, the excess of chlorine removed by boiling, and the solution decolorized while boiling with standard solution of stannous chloride.

It may be proper to state here that for estimating sugar in solutions by means of the copper liquor the cane sugar must be changed to inverted sugar by boiling from 30 to 40 minutes after addition of about 10 per cent. its volume of normal sulphuric acid (containing 10 per cent. anhydrous acid) and subsequently neutralizing the acid by means of an alkali. The sugar solution is then added to the boiling copper solution until complete decoloration; or, the process reversed, the copper solution being added in excess to the boiling sugar solution, and the superfluous cupric oxide determined by other methods, volumetrically or otherwise; or the cuprous oxide reduced may be collected and weighed, and the sugar equivalent calculated from the amount found.

But, as before stated, we do not propose here to give in full the chemical methods employed for determining sugar, and we must therefore refer the reader to works on analytical chemistry for further details.

We now come to the methods of selecting seed and seed-bearers, and the principles upon which they depend. Of all the experiments and investigations in the direction of improvement of this culture, none seem

* Here, as in some other places in this report, I give the value in French weights and measures, because they are generally employed in laboratory work and are of so much greater convenience. Apparatus graduated to these measures may be obtained from all dealers in chemical glassware.

to have made such rapid strides in advance as in this line of work, none have given results more fruitful and of a character so well suited to ameliorate the relations between the producer and manufacturer, and at the same time be a source of profit to both.

The initiatory steps in this work in France seem to have been taken by Mons. Louis Vilmorin, the former head of the great house of Vilmorin, Andrieux & Co., of Paris, and his methods of working, followed by similar results, are still being prosecuted with rare intelligence and skill by his son and successor, Mons. Henri Vilmorin, whose contributions to our knowledge of this and other cultures have done so much to clear up the many difficulties which surround and accompany the profitable management of the several agricultural industries.

Of the outward characteristics which aid in determining the richness of beets, we have found the most important, as recognized in France, to be size and form of the root, its density, the number and appearance of the leaves, &c., and all these properties will be mentioned in the general rules for selection. But thus far we have failed to notice the external and internal characteristics of the seed, which have been found to have an important bearing upon the character and value of the crop; and, before proceeding to the effects of selection in securing desirable crops, we shall call attention to the relation of the character and composition of the seed upon the quantity and quality of the roots produced from it. In this connection we must again refer to the valuable little work of Champion and Pellet, in which these authors and investigators take issue with, or rather proceed further than, Walkhoff, who advises selection of the larger seeds for planting because they give more robust plants. This is true as far as it goes, but the authors above mentioned, also finding the relation of seed to the value of the crop to exist, find further that while the larger seeds give roots of larger volume and weight, the smaller seeds give smaller roots, which are richer in sugar. Thus taking two lots of seeds produced by Simon Legrand, one lot having an average weight of 3.2 grams per 100 seeds taken, and another lot having an average weight of 0.425 grams per 100 seeds, the determination of the weight of the roots produced and their saccharine richness gave the following results:

Dates.	Average weight of four roots.	Sugar in roots.
One large seed:	*Grams.*	*Per cent.*
August 11	66	
August 20	75	11.4
August 31	125	
September 16	375	11.8
Two small seeds:		
August 11	30	
August 20	50	12.0
August 31	75	
September 16	233	12.5

Dubrunfant is of the opinion that seeds having the highest specific gravity are more suitable for planting than those of lower density. He effects a separation by placing the seeds in water and after a time removing those which float, preserving those which sink to the bottom of the containing vessel. He states that the two qualities of seed behave quite differently both in germination and during growth. Champion and Pellet* quote Basset as saying, "It is well to do the same for seeds as is done for roots for reproduction, and choose the heavier ones, or those that fall to the bottom of a bath prepared with water and salt."

The chemical composition of the seed has also been the subject of study by different chemists.

Dubrunfant,† by a chemical examination of the seeds taken from a crop of 30 acres of sugar and forage beets, and furnished him by the house of Vilmorin, Andrieux & Co., in Paris, found that the seeds of the sugar-yielding races give upon incineration a smaller weight of ash than the forage races, and the differences, which vary within certain limits, are all, with few exceptions, in the same direction. Comparing weights of seed taken and ashes produced, the proportion for the sugar-forming races varies between 4.50 and 6.50 per cent. The forage races give from 6 to 14 per cent., making an average of 7 to 8, which is very different from the proportion given by sugar-yielding races.

It also appears that the ash of the sugar-forming races is richer in phosphoric acid, potash, and even magnesia. Thus the seeds of the sugar races give 0.004 to 0.008 per cent. of their weight of phosphoric acid, while the seeds of forage beets gives but 0.0002 to 0.0005 per cent. A similar relation exists for the potash. Thus for the sugar races a sufficient quantity is always present to develop a green color with the manganese in the ash by fusion, while in the forage races this is not the case. But if to the ash of the latter a small quantity of potash be added, the characteristic green coloration produced by manganese is readily developed by the application of heat.

The conclusions of Dubrunfant confirm the results of the analyses of Pellet.‡

	Per cent. of ash in dry matter.
Vilmorin seed (average)	6.0
Sugar beets	7.4
Forage beets	8.0

* *La Betterave à Sucre*, p. 29.
† *La Sucrerie Indigène*, xiii, 428.
‡ *La Betterave à Sucre*, p. 31.

The results of the chemical analyses of the ashes are as follows:

	Ordinary seed of the sugar factory.		Improved Vilmorin seed.
	No. 1.	No. 2.	
Potash	21.1	16.4	24.2
Soda	8.9	10.4	12.8
Lime	25.4	20.2	17.2
Magnesia	13.5	11.5	10.1
Sulphuric acid	4.0	2.8	4.3
Chlorine	4.7	4.1	4.1
Phosphoric acid	8.4	9.3	17.4
Silica	13.4	.....	.....
Oxide of iron	1.2	26.4	11.0
Manganese	0.7	.....	.....
Total	101.3	101.1	101.1
Deduction of oxygen for chlorine	1.3	1.1	1.1
	100.0	100.0	100.0

On the other hand, seeds of rich beets contain a higher proportion of nitrogen than seeds of poorer beets, and at the same time small seeds contain more nitrogen than large ones, as is evidenced by the following results of examinations by Champion and Pellet:

Vilmorin seed.	Weights of 100 seeds in grams.	Per cent. water in normal matter.	Per cent. nitrogen in normal matter.	Per cent. ash in normal matter.	Per cent. nitrogen dry matter.	Per cent. ashes in dry matter.	Per cent of nitrogenous matter in dry material.	Alkalinity of ash expressed in SO^3HO.	Average per cent. sugar in beets.
Large seeds	4.130	10.9	2.66	5.4	2.98	6.061	8.6	14.9	15
Small seeds	0.546	11.0	3.07	5.3	3.44	5.95	21.5	13.1	
SUGAR BEET.									
Average of the varieties: Graytop, greentop, large seeds	4.745	12.2	2.46	6.5	2,80	7.4	16.8	.....	10
German acclimated, pink top, small seeds	0.777	11.2	2.80	8.2	3.15	.....	19.68	.....	
FORAGE BEETS.									
Ox-horn, German yellow, large seeds	4.647	12.5	2.38	7.0	2.74	8.0	14.87	13.6	4 to 6
Pink field, red globe, small seeds	0.560	11.4	2.55	9.0	2.87	.....	15.93	12.4	

These relations between the richness of the beet and the composition and size of the seeds, furnish the bases of ready and valuable means of selecting the good and separating them from the worthless. The method recommended is to pass them over a screen with meshes of a given diameter, which unfortunately has never been determined, or at least stated, and to throw those which pass through in water or a solution of salt, rejecting those which float. Those which sink combine the valuable properties above described, of small size and high specific gravity. In the processes of selection as applied to choice of beets for production of seed, which really constitutes the production ot new races, the end really to be attained is the ultimate development of a race, or of races,

which will at the same time satisfy the demands of the producer and the manufacturer; that is, that will give a large yield to respond to the demands of the former, combined with good quality and high richness in sugar to respond to the demands of the latter. In the opinion of some of those who have devoted themselves to this work, the hope of a result such as we have described must be considered almost useless, if we depend upon the root and its characteristics, but much valuable assistance may be rendered in the attainment of this end, as we shall see later on, by the intelligent application of fertilizers to the crop and the methods of culture adopted and employed.

In the earlier experiments in this line, those of Mons. L. Vilmorin, attention was more especially directed to the production of very rich beets, with no particular care to the size, the desire being rather to obtain beets of small size, with tapering form and smooth surface; but the late work of all engaged in this kind of experiment and research has been directed to the enrichment of races giving roots of larger volume and fuller form, making them better adapted to all soils and all methods of culture. In most cases, therefore, the work starts from the races most extensively grown.

Vilmorin began his work by following the method employed in Germany of taking the specific gravity of the roots by plunging them in saline solutions of known density, but he soon found that, in consequence of the almost constant presence of an internal cavity, this method was inexact.

Dubrunfaut further explains the cause of the inaccuracy of this method in the fact of the existence of air and gases within the body of the root. Vilmorin therefore resorted to the method of taking from the center of the root under examination a cylindrical portion by means of a cutting tube, and determining the density of the portion thus obtained, in solutions of sugar of known specific gravity, but these solutions were discarded on account of their unstable character, and similar solutions of salt substituted. But the loss of sugar in the sample by osmosis when immersed in the saline solutions renders this mode of procedure also unsuited to the attainment of the end in view, and he finally turned to the determination of the density of the juice itself as the readiest and most exact means of determining the sugar content of the sample. The sample removed from the beet, furnished on grating and pressing sufficient of juice to admit of taking the weight of a metallic cube of known dimensions immersed in it, from which the density of the juice could readily be calculated. This method of determination he found to give more accurate results than any other when working upon so small a quantity of material.

It is useless to add [he says in his paper read before the Academy of Sciences in November, 1856] that the temperature taken by means of a thermometer with tenths of degrees is carried on the register after each weight of the ingot, and that the gauge of the vases, the fineness of the suspending thread, and the identity of all the conditions of the operation eliminates errors which at first produced certain irregularities in the manner of working.

Having thus determined the specific gravity of the juices of the various beets under examination, those considered worthy of propagation are preserved and the others rejected. The surfaces of the wounds produced in the beets examined by the removal of the sample is covered with charcoal dust, which effectually prevents any decay or deterioration in consequence of the treatment to which the roots have been submitted.

This method was employed in the development of the race of beets known as Vilmorin's Improved, and it is this method or modifications of it, or some additional operations carried on in connection with it, that is employed to-day by the most intelligent and responsible producers of improved seed in France.

Mr. Henri Vilmorin, who has succeeded his father in the work, combines the method with examination of the sample of juice, after the determination of its specific gravity, by means of the polariscope, while others employ, as supplementary to the method, estimation of the sugar by means of the copper test.

But notwithstanding the unfavorable conclusions concerning the method of selection, based upon the density of the roots as determined by immersing them in solutions of molasses or salt of differing but known strengths, it is still used by many of the leading seed-growers in the North of France. M. Demiatte, in an article on the subject of selection of seed-bearers, states* that he proceeds as follows, according to Brabant's method: Select subjects weighing at least 700 grams (1½ pounds). For determination of their density they are thrown into a vat partly filled with a solution of molasses, having a density of 2.5 degrees by the densimeter; those roots which float are rejected; those which partly sink are preserved for the production of seed called No. 3. Those which sink completely are thrown into a second vat containing a solution similar to that just described, but having a density of 3.5 degrees. Those which float here are preserved for production of seed known as No. 2. Those which sink to the bottom are of course of the best quality, and are used for production of seed No 1.

We have seen that the generally adopted opinion concerning the best form of beet to be chosen for production of high yields of sugar is to the effect that the long, tapering ones are the most valuable; but this opinion is likely to be subject to modification in consequence of the results of later observations upon the constitution of the improved varieties and their power to resist the deteriorating influences to which they may be subject in the varying conditions of soil and culture. The tapering, richer, improved races, descended from German stock, have been found more subject to disease in France than the poorer races of the country, and M. Decrombecque, at Lens, conceived the idea of incorporating within the latter the sugar-producing qualities of the former, and

*Journal des Fabricants de Sucre, 1879, February 19.

at the same time retaining the hardiness for which the commoner races are well known. To attain this end he had recourse to the method suggested by Walkhoff,* who believed that the saccharine richness of beets may be improved by crossing, and who was able by using seeds of Frickenhouse, and the method referred to, to obtain beets the juice of which marked 18.8 degrees, Balling, and containing 16.5 per cent. of sugar, starting with varieties the juice of which showed but 17.8 degrees, Balling, and containing 16.35 per cent. of sugar. In planting, the roots were placed in close contact so that the blossoms touched each other, and the slightest agitation was sufficient to effect the transport of pollen.

But the results of the experiments and of the practice adopted by Mons. Decombrecque† are rather more striking than those obtained by Walkhoff. He noticed when he began his work at Lens that the Silesian beet grown upon a rather shallow soil, and especially when manured with stable manure containing considerable straw, in the spring (well known to be a bad and injurious practice), was hairy, fusiform, and wanting in weight. At the same time the white beet of the country, with green top, gray flesh, and obtuse form, flourished and developed well, though remaining pyriform in the same field in which the Silesian fared badly. The question was to produce a beet having the hardiness of the one and the richness of the other. He chose from his crop the best formed, richest subjects, of *size above the average*, well covered in the ground, and then, observing the same care, chose specimens of the country roots, called *toupie* (about the poorest of all the beets grown), and the beets thus chosen he preserved for seed. In planting he combined them in the proportion of five plants of the Silesian with one of *toupie*. In collecting the seed he carefully preserved separately that from the Silesian varieties and that from the toupie, and in subsequent sowing used only that from the Silesian. He found that the character of the Silesian beet had changed, and that the beet had the obtuse form. However, after the third year of planting the modified seed, he found that the good qualities of the Silesian had disappeared, and he had only the low-grade beet of the country. His subsequent practice, therefore, was to grow two or more acres of Silesian, and from the crop produced to select those he needed for seed, and these roots he mixed with roots from the ordinary crop in the proportion of 1 to 3, and thus secured continuously the hardiness of the one and the richness of the other combined.

With the indications given by Mons. H. Vilmorin in his description of the leading races of beets grown in France, and the methods described in the preceding pages, it will not be difficult for the prospective grower to determine the varieties that will be best suited to his purposes, or to produce new races through which the results he desires may be obtained, but it will not be out of place here to call attention to the experiments of Mons. Derome at Bavay (Nord) made with seeds obtained from various

* See *La bettrave à sucre*, par Champion and Pellet.

† *La sucrerie indigène*, xii, 434.

producers with a view to the determination of the best varieties for cultivators to grow in order to secure a crop of quality and quantity to be satisfactory both to themselves and the manufacturer. This he conceives to be a variety that will give the most sugar per acre, in condition to be most easily extracted in the greatest weight. Without entering into the details of his experiments we shall simply give in the following table the names of the varieties of seeds grown and the results obtained:

Varieties.	Number of plants per acre.	Yield per acre.	Density at 60° F.	Gross yield in sugar.	Price of beets per ton of 2,200 pounds.	Sum realized by the grower per acre.	Sugar of 88° extractable.	
							Per 100 lbs. of beets.	In quantity harvested per acre.
		*Tons.**	°	*Per ct.*			*Pounds.*	*Tons.**
1. Long pink toupie	33,205	20.1	5	8.431	$4 00	$80 00	4.69	0.94
2. Silesian, pink, fusiform	34,210	18.0	5.70	10.766	4 64	83 00	6.84	1.23
3. Silesian, pink, fusiform	32,388	15.9	6.40	12.841	5 64	81 00	8.34	1.33
4. Silesian, white, first choice	32,344	11.9	7.15	13.769	6 80	78 00	9.27	1.07
5. Silesian, white, second choice	32,266	16.0	5.95	10.921	4 94	79 00	6.84	1.09
6. Silesian, white, acclimated	35,060	15.9	6.10	11.473	5 16	32 00	7.34	1.16
7. Silesian, white, acclimated	34,656	14.9	6.15	11.194	5 48	65 00	6.97	1.04
8. White pink top	37,627	16.8	5.75	11.538	4 70	79 00	6.50	1.09
9. White improved	32,759	11.4	7.20	11.368	6 92	78 00	8.68	0.99
10. White green top	34,210	15.3	5.90	10.912	4 88	73 00	6.89	1.05
11. Pink acclimated	31,983	13.8	5.90	10.736	4 88	68 00	6.67	0.92
12. White silesian	32,874	14.2	6.10	11.126	5 10	73 00	6.93	0.98
13. Pink silesian	33,966	15.1	6.05	10.825	5 08	79 00	6.69	1 01
14. Pink silesian	33,400	17.9	5.45	9.957	4 36	78 00	6.02	1.08
15. Pink Brunswick	31,583	17.5	5.40	9.709	4 32	75 00	5.86	1.02

* Of 2,200 lbs.

He concludes from the figures obtained and here given, that the best beets to be grown, and which he considers the races of conciliation, are those represented by the numbers 2, 3, 5, 6, 7, 8, 10, and 14. If sold according to the density of the juice and the scale of values in the form of arbitration adopted by the sugar manufacturers at Lille,* the grower will receive a higher return per acre than with any of the other varieties mentioned.

In this connection the results of the experiments of Deherain are relevant and interesting. He says:†

It follows from our experiments and analyses that beets submitted to different modes of feeding or fertilizing, preserve in their development the native qualities of the seed, *i. e.*, their race.

In several of the experiments, pink tops and improved Vilmorins were submitted to exactly the same conditions, same sterile soil, same manures given in equal quantities, yet in one case while the pink top contained 7.5 per cent. of sugar, the improved beet contained 16.2. In another case when the fertilizer was more nitrogenous, the richness of the pink-top beet fell to 5.5 per cent. and the Vilmorin to only 13.4. This shows clearly the influence of race upon the saccharine quality of the beet. The conclusions would appear premature were these experiments the only evidences to support them, but they are also confirmed

* See later on in discussions of relations between the grower and manufacturer.

† *Annales agronomiques.*

in the results of experiments made by Mons. H. Vilmorin at Verriers, according to Prof. Deherain's suggestions.

With reference to the type of beet to be chosen, Mons. Demiatte* says:

The nature of the soil and method of culture being known, the form should change with the nature of the soil; should be long and tapering in deep sandy or alluvium soils; short and more obtuse in shallow soils like that near Arras, where the thickness of the arable layer will not exceed 6 inches. But whatever be the type chosen the top of the mother beet should not protrude from the soil more than one-fourth its total length.

With the facts and figures presented, which have all been worked out in France by careful experiment and investigation, no further comments on the different French races will be necessary. The selection of varieties for cultivation can best be left to the reader. We believe, however, it will be of interest, and we shall, therefore, conclude the consideration of this subject by giving the names and addresses of several of the leading producers of seed in France who made exhibition of their products in the late Paris Exposition of 1878, with short notices of the character of their exhibits.

Desprez père et fils, Capelle.—The varieties produced are No. 1, white or pink, containing 15 to 18 per cent. sugar, requiring deep, rich soil, plenty of manure, and excellent culture; yields 16 to 20 tons per acre. No. 2, white or pink, 12 to 15 per cent. sugar, for ordinary soil, fertilzing, and care; yields 20 to 25 tons per acre. No. 3, 10 to 12 per cent. sugar for inferior soils and cultures; yields 25 to 30 tons per acre.

Simon-Legrand, Auchy.—Different varieties containing 12 to 20 per cent. of sugar; some varieties of special selection containing from 20 to 23 per cent.

L. Dervaux-Ibled, Wargnies-le-Grand—Cultivates seed by special method of selection depending upon taking specific gravities of cylindrical samples cut from the roots and immersing them in saline solutions of given strength.

Brabant frères, Onnaing—Cultivate seed of special variety bearing their name; claimed to produce 21 tons per acre, of beets of average richness of 14.88 per cent. of sugar.

Vilmorin, Andrieux and Co., No. 4 Quai de la Megisserie, Paris—Produce seed from five varieties, given in the table below, showing the industrial value of each variety.

	Green-top beet.	Improved Vilmorin beet.	French races.		German race.
			Pink top.	Green top.	
Yield, per acre ..... long tons..	33.117	16.639	30.121	30.049	23.360
Sugar, per gallon of juice ..... pounds..	1.12	1.63	1.24	1.20	1.30
Sugar, per acre ..... do....	8,437	5,601	8,754	8,595	7,029
Sugar, per long ton of beets	149.6	290.4	182.6	173.8	222 2
Approximate industrial yield ..... per acre..	4.468	3.095	4.893	4.739	2.308

* Journal des Fabricants de Sucre, February 19, 1879.

CHAPTER V.

CULTURE, CHOICE OF SOIL, ITS PREPARATION, PLANTING, CARE OF, HARVESTING AND PRESERVING CROP.

CULTURE.

The cultural conditions to be regarded as of greatest importance in securing crops of maximum quantity and quality, when a section has been determined upon by a consideration of all other conditions, are choice of soil, &c., its physical character and chemical composition, and the methods by which these may be modified or improved; the first by the mechanical methods of culture, and the second by the proper and judicious applications of fertilizers. After this will naturally follow the modes of planting and the care to be applied during the season of growth.

With reference to the choice of soil suited to the culture of the beet-root, opinions seem to differ somewhat, though the principles which appear to govern them tend to the same end. The illustrious Chaptal,* as a result of his study of the plant and its requirements, arrived at the following conclusions:

Soils which are dry, calcareous, light, &c., are not well suited to the beet.

Strong clay soils have little aptitude for the culture of this root.

In order that the root may prosper, it needs, in general, a mellow, fertile soil, the arable stratum of which should be 12 to 15 inches thick.

The root succeeds more or less well in all arable soils, but the products vary wonderfully according to the nature of the soils.

Basset† considers that "a fresh soil, rather sandy or silico-calcareous than too calcareous or argillaceous, rich in humus, and deep," should be chosen. Briem,‡ in his late work on beet-root culture and sugar manufacture, says, of the physical character of the soil to be chosen, "it should not be too light nor too moist; it should be bare; its subsoil permeable; it should be warm, free from stones, calcareous, and should contain humus." Deherain,§ from the results of his experiments and investigations at Grignon, publishes as one of the conclusions arrived at that the nature of the soil does not seem to exercise any sensible action upon the development of the beet, for the same results were obtained in soils consisting of pure silica, of calcareous matter, or of a mixture of calcareous matter and clay.

Vivien‖ found in traveling through the provinces of the Rhine, Hanover, Brandenburg, and Saxony in Germany, that, though in each section there is a wide difference in the nature of the soil, there is a particularly marked homogeneity in the character of the beets.

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* Quoted by Basset in *Guide Pratique du Fabricant de Sucre.*

† *Ibid.*

‡ See *Critique* in Journal des Fabricants de Sucre, 1879.

§ *Annales Agronomiques.*

‖ Journal des Fabricants de Sucre, 1878, 27 March.

Vilmorin considers that any good soil that will grow wheat and corn, and has an arable stratum of 12 to 15 inches, will be well suited to this culture; that where chalk exists in large proportion the yield will be small, but the juice pure. All soils should be thoroughly drained, so that the tap root may not find stagnant water in the subsoil.

Notwithstanding the differing notions expressed above, it will appear that the physical characters of the soil which tend to render it best suited to the cultivation of the beet are porosity of surface and subsoil, to admit of drainage of superfluous water and of free circulation of the air, and power of absorbing and holding in a condition convenient for ready assimilation the elements of plant-food existing within it or coming from external sources. Unless the supply of these elements be continuous and regular, a purely sandy soil would be undesirable. If no means were provided for the removal of surplus water which might be found in a purely clay soil, or to so improve its condition as to admit of free circulation of air as well as water, it is too heavy, and becomes absolutely useless. The same is true of purely calcareous soils, since the same unfavorable conditions would prevail, though perhaps to not quite the same extent. These soils would also be unsuited to the plant itself, because they would not admit of the free progress of the tap root nor of the lateral fibrous roots in their search for nutrition or in following the natural course of development, and, as will appear later on, these conditions have a powerful influence upon the ultimate yield of sugar from the surface cultivated. But if the sandy soil described be mixed with either or both of the others mentioned, and with humus, in suitable proportions, the conditions most favorable to the maintenance of a regular and plentiful supply of food, the healthy condition of the root, and its consequent normal development, will be assured.

The chemical character of the soil is of quite as great importance as its physical condition. For the proper development of the beet for the production of sugar it should contain in a suitable and assimilable form all the elements usually necessary to the normal existence and development of plants, and attention must therefore be had to the conditions in which these substances exist in the soil. Phosphoric acid, potash, nitrogen compounds, and lime are especially necessary to the life of the plant, but if these exist in insoluble combinations on the one hand, or in forms suitable for assimilation but in excessive quantities on the other, they will either be useless in the economy of nutrition in the first instance, or will stimulate the plant to abnormal growth unsuited to the ready extraction of sugar in the second. It is this branch of the subject that has occupied the attention and enlisted the energies of scientists and landed proprietors, and the influence of the different combinations of the various leading elements of plant-food, and more especially, during later years, of nitrogen in the soil, has constituted the subject of frequent and continued investigation.

Basset* says:

Soils charged with mineral salts are injurious to the culture of the beet for extraction of sugar and are only suited to the cultivation of beets for distillation. In fact, we know that the beet easily absorbs saline matters and that the alkaline salts constitute one of the greatest obstacles to sugar extraction.

New ground or that lately cleared of forest should not be applied to the culture of the beet, and it is considered by good authorities to be detrimental to the quality of the crop to make use of lands for this purpose that have not been under continued cultivation at least ten or fifteen years. This insures an almost complete removal of the nitrates and the organic matters containing nitrogen, which are always present in large quantities in new soils, and which it is well known exert an injurious influence upon the quality of the root.

Basset, in his work,† gives elaborate tables of analyses of soils to show the chemical composition of those most favorable to the culture, but we will here give the more succinct tables of Champion and Pellet,‡ showing the composition of soils from different departments in the north of France in which beet-root culture is most extensively carried on, and of one from a similar section of Russia. Those numbered 1, 2, and 3 yielded beets of fair quality, containing 12 to 14 parts of sugar per 100 of juice, while that numbered 4 gave beets of bad quality. The last, that from Russia, is quoted by Walkhoff as being well suited to beet culture.

	1. Somme.	2. Nord.		3. Aisne.	4. Somme.	5. Kalinofska soil.
Organic matters	5.600	4.42	4.840	5.70	8.200	6.207
Silica	81.800	.....	82.500	79.00	42.000	72.699
Alumina	7.240	.....	8.620	8.50	3.91	9.974
Lime	0.570	0.476	0.420	0.25	23.220	1.930
Peroxide of iron	2.880	.....	2.180	5.50	2.310	2.834
Phosphoric acid	0.070	0.008	0.077	Trace..	0 385	0.093
Potash	0.064	0.130	0.140	Trace..	0.044	2.047
Soda	0.085			.....	0.058	0.914
Carbonic acid	0.400	0.600	0.700	2.85	19.050	1.280
Other matters	1.351	.....	1.523	.....	0.823	2.022
	100.000	100.000	100.000	100.000	100.000	100.000
Total nitrogen	0.088	0.140	0.120	0.154	0.270	0.234
Ammonia	0.013	0.040	0.030	0.016	0.010	.....
Sand	72.100	85.000	80.000	62.000	35.770	.....
Clay	22.000	9.000	14.000	30.000	10 to 12	.....

The same authors quote Schübler as giving the following as the general composition of good soil for beet culture:

Clay	33.300
Siliceous sand	63.000
Calcareous sand	1.200
Calcareous earth, humus	2.500

* *Guide Pratique du Fabricant de Sucre.*

† *Guide Pratique du Fabricant de Sucre.*

‡ *La Bettrave a Sucre*, p. 82.

We now come to the study of the means employed to supply the deficiencies of plant-food in the soil, due either to the natural condition or the exhaustion by crops, and the influence of the means employed upon the production of rich and valuable roots.

The general composition of the beet root and leaves is given by Champion and Pellet, as follows: They state that for rich beets the weight of leaves is about 50 per cent. that of the root, and 25 to 30 per cent. that of roots containing 9 to 11 per cent. of sugar.

The table shows the general composition of leaves and roots of beets containing 15 per cent. of sugar:

	In roots.	In dry matter.	In leaves.	In dry matter.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Water	74.00	.....	83.50	.....
Nitrogen	0.40	1.55	0.38	2.30
Ashes	0.80	3.10	4.35	26.20

For a yield of 20 French tons* of beets and 10 French tons of leaves per acre, there would be removed from the soil:

	Nitrogen.	Total ashes.
	Pounds.	*Pounds.*
20 tons roots	178.1	356.2
10 tons leaves	84.8	934.1

Or, for an average richness of 11 per cent. of sugar:

	In roots.	In dry matter.	In leaves.	In dry matter.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Water	82.00	.....	84.50	.....
Nitrogen	0.25	1.39	0.38	2.45
Ashes	0.95	5.30	3.85	24.8

Or, for a yield of 20 French tons per acre:

	Total nitrogen.	Total ashes.
	Pounds.	*Pounds.*
20 tons roots	110	418
6 tons leaves	50	508.2

* 2,200 pounds.

The composition of the ashes of the leaves and roots referred to 1,000 parts green matter is as follows:

	Beets supposed to contain 10 per cent. sugar.		Beets supposed to contain 15 per cent. sugar.	
	Leaves.	Roots.	Leaves.	Roots.
Potash	9.23	2.93	10.0	2.66
Soda	3.23	0.51	3.47	0.45
Lime	3.50	0.42	3.75	0.38
Magnesia	2.81	0.38	3.03	0.33
Chlorine	3.23	0.57	3.47	0.50
Sulphuric acid	1.50	0.22	1.63	0.19
Silica	0.31	0.34	0.33	0.30
Phosphoric acid	2.23	0.59	2.40	0.51
Undetermined	2.03	0.16	1.92	0.13
Total mineral matters	28.07	6.12	30.0	5.45
Total solids	138.0	167.5	140.0	240.0
Nitrogen	3.3	2.5	3.8	4.0

From these figures we may easily determine the quantity of the different constituents removed by average crops. Supposing the average to be 20 tons of roots per acre, the consumption of the different constituents would be, for beets of differing richness, as shown in the following table:

	For beets containing 10 per cent. sugar.		Total.	For beets containing 15 per cent. sugar.		Total.
	Six tons leaves.	Twenty tons roots.		Ten tons leaves.	Twenty tons roots.	
Potash	121.8	128.9	250.7	220.0	337.04	117.04
Soda	42.6	22.4	65.0	76.34	96.14	19.8
Lime	46.2	18.48	64.68	82.50	89.22	16.72
Magnesia	36.1	16.72	42.82	66.66	81.18	14.52
Chlorine	42.6	25.08	47.68	76.34	98.34	22.0
Sulphuric acid	19.8	9.68	29.48	35.86	44.22	8.36
Silica	4.09	14.96	19.05	7.26	20.46	13.2
Phosphoric acid	29.43	25.96	55.39	52.80	75.24	22.44
Undetermined	26.79	7.04	33.83	31.24	36.94	5.70
Total	369.41	248.32	628.50	651.00	888.18	239.78
Dry matter	1,821.6	7,370.00	.....	3,080	.....	10,560
Nitrogen	43.56	110.0	.....	83.6	.....	176.0

In France the general sources of supply of the various nutritive principles for the restoration of those removed by the crops, or to provide those required, are found in stable manure, seed cakes, animal wastes, woolen scraps, sulphate of ammonia, nitrates, superphosphates made from bones and minerals, potash salts, gypsum, and the scums and refuse from the sugar factories. Of all these substances, that which combines in itself in the highest degree all the elements of plant-food, and which is naturally the most economical, is the stable manure produced on the farm, and this being generally the result of keeping cattle to be fed upon the pulps from the factory is one of the sources of real profit to the producer.

Joulie gives the following as the composition of French stable-manures of average quality, estimated in pounds per ton of 2,000 pounds:

	Manure of fifteen oxen.	Manure of ten cows.
Water	1,492.576	1,398.656
Organic matter	406.044	476.928
Mineral matter	101.380	124.416
Total	2,000.000	2,000.000
Nitrogen:		
Nitric	0.000	0.000
Ammoniacal	1.880	1.334
Organic	11.822	11.950
Total	13.702	13.284
Phosphoric acid	5.288	3.142
Sulphuric acid	3.010	3.000
Chlorine	2.740	4.000
Potash	19.104	20.852
Soda	5.164	6.284
Lime	14.538	14.060
Magnesia	3.770	3.478
Oxide of iron	1.304	1.250
Sand and silica	39.888	60.913
Carbonic acid and loss	6.574	7.438
Total	101.380	124.416

A comparison of this table with that given before will show that in order to supply in stable manure the required nitrogen and phosphoric acid for the production of an average crop of 20 tons per acre, it will be necessary to apply at least 20 tons of stable manure to the same area. But this quantity will contain a considerable excess of alkaline matters over the quantity demanded by the crop, and will only tend to increase the saline constituents of the root at the expense of the sugar. This excess of mineral matters is often used to explain the production of roots of low saccharine value. Let us bring together the figures for the constituents of plant-food mentioned, as found in 20 tons of stable manure from cows and as found in the yield of an acre giving 20 tons of beets:

	Manure.	Beet crop.
	Pounds.	
Nitrogen	265.680	259.6
Phosphoric acid	62.840	75.24
Potash	417.040	337.04
Soda	135.680	96.14
Lime	281.200	89.22

In practical work, therefore, it is found better to reduce the quantity of stable manures applied, and to supplement them with the other substances mentioned above. A comparison of the productive influences exerted by stable manures and by the artificial compounds usually employed to supplement it, or as substitutes for it, will be found in the following table, showing the results of the experiments made by Professor Deherain at the Grignon agricultural school, working with the Vilmorin improved race of beets. These results are interesting as showing the

advantage of moderate applications of stable manures, and the choice that should be made in the supplementary compounds that should be applied:

*Influence of manures on yield in weight and richness in sugar.**

No. of the plots.	Manure distributed per acre.	Yield per acre.	Sugar in juice.	Sugar produced per acre.
		Tons.	*Per cent.*	*Pounds.*
1	9 tons stable manure	9.2414	12.67	2,351.80
2	18 tons stable manure	8.8893	12.58	2,228.60
3	36 tons stable manure	8.4378	11.28	1,896.59
4	36 tons stable manure and 890.7 pounds superphosphate of lime	8.7220	12.26	2,137.78
5	Without manure	6.1980	14.58	2,257.04
6	356 pounds nitrate of soda, distributed in one sowing	8.4378	12.75	2,184.01
7	356 pounds nitrate of soda, distributed in four sowings	8.7660	12.75	2,234.79
8	356 pounds nitrate of soda and 356 pounds superphosphate, in one sowing	9.1220	13.23	2,415.46
9	356 pounds nitrate of soda and 356 pounds superphosphate, in four sowings	9.9235	13.08	2,568.24
10	1,068 pounds nitrate of soda, distributed in four sowings	8.5230	12.43	2,367.40
11	356 pounds sulphate of ammonia, distributed in one sowing	8.4378	13.89	2,336.25
12	356 pound ssulphate of ammonia, distributed in four sowings	7.7985	12.75	1,962.45
13	356 pounds sulphate of ammonia and 356 pounds superphosphate, in one sowing	6.5860	13.08	1,722.15
14	356 pounds sulphate of ammonia and 356 pounds superphosphate, in four sowings	6.9360	13.08	1,827.17
15	356 pounds superphosphate withhout nitrogen or manure	7.5205	13.24	1,990.93
16	1,068 pounds sulphate of ammonia, in four sowings	6.4970	12.42	1,693.57

* *Journal des Fabricants de Sucre*, November 13, 1878.

Joulie* also found, in his experiments with stable manure and the different fertilizing compounds made according to his formula, that the largest yield was obtained with the complete manure containing all the leading elements. The next best yield was secured with the complete manure without potash; the next with nitrate of soda alone. The yields with the others decreased regularly in the order in which they are named. Without phosphate and without lime; with sulphate of ammonia; with stable manure; with nothing; with guano. From his experiments he concludes as follows:

1. The manure especially suited to the beet and which establishes the best conditions, as well for the yield per acre as for quality, is the complete manure B, of which the following is the composition:

	Per cent.
Nitric acid	6.500
Phosphoric acid, { assimilable / insoluble }	6.500
Potash	8.000
Soda	9.000
Lime	14.800
Water, sulphuric acid, silica, and other accessory elements	55.200
Total	100.000
The nitrogen corresponds to ammonia	8.000
The phosphoric acid corresponds to tricalcic phosphate	14.200

* *Guide pour l'achat et l'Emploi des Engrais Chimiques*, pp. 250 and 251.

2. In soils provided with potash it (the manure B) is advantageously replaced by the manure F,* which differs only in the substitution of soda for potash.

3. These two manures should be applied at the rate of 400 pounds per acre upon soils in good condition and without stable manures.

4. Stable manure, applied at the rate of 20 to 25 tons per acre in the same year that the crop is grown, constitutes a bad condition, which it is prudent to avoid. It is better to reduce the stable manure to 10 or 12 tons and supplement it with a suitable addition of chemical manures. Thus putting the minimum of salts, particularly of potash, at the disposition of the roots, a better quality will be obtained.

5. If stable manure be applied at the rate of 10 to 12 tons per acre, which rate it has been found advisable not to exceed, the manure F without potash should preferably be employed at the rate of 200 pounds for good soils and of 400 pounds for poor soils. We thus avoid excess of potash, and establish between the useful elements an equilibrium favorable to the crop.

6. If fossil phosphates have been added to the stable manure after the method suggested by Baron P. Thenard, the manure F may be replaced by nitrate of soda at the rate of 260 pounds per acre for good soils and a maximum of 350 pounds for poor soils.

7. In no case should salts of potash (nitrate, sulphate, or chloride) be added to stable manure, which is always sufficiently rich in this element.

From these and later experiments Mons. Joulie concluded, in general, concerning nitrogen of various compounds in its relation to the beet root and the influence upon its sugar content, that the nitrogen of the nitrates is more effective than that of ammonia, which in its turn is more valuable than that of organic matter.

This difference in the elements of plant-food has also been noticed and determined by other workers, who have arrived at conclusions quite as marked as those of Joulie just given. Pagnoul† states that experiments made at Arras and elsewhere lead to the following conclusions concerning the use and abuse of nitrogenous compounds:

1. Abuse of all nitrogenous compounds, nitrates, stable-manures, seed-cake, &c., is always injurious to the quality of the beet.

2. Excess of nitrates by application before sowing is less injurious than excess of

* The conclusions of Professor Joulie will be better understood if reference is made to the following table, showing the composition of the fertilizers, made according to his various formulæ:

Denomination of manure.	Nitrogen.			Phosphoric acid.			Potash.	Soda.	Lime.	Accessory elements.
	Ammoniacal.	Nitric.	Total.	Assimilable.	Insoluble.	Total.				
Manure A complete	4.14	2.36	6.50	5.00	1.50	6.50	8.00	.....	17.00	62.00
B complete	.....	6.50	6.50	5.00	1.50	6.50	8.00	9.00	14.80	55.20
C complete	.....	4.00	4.00	5.00	1.50	6.50	14.00	.....	19.00	56.50
D complete	.....	2.50	2.50	8.00	2.50	10.50	8.00	.....	20.00	59.00
E without potash	6.50	.....	6.50	5.00	1.50	6.50	.....	.....	19.50	67.50
E concentrated	9.00	.....	9.00	9.00	2.00	11.00	.....	.....	12.00	68.00
E without potash No. 2	3.00	.....	3.00	14.00	2.00	16.00	.....	.....	22.00	59.00
F without potash	.....	6.50	6.50	5.00	1.50	6.50	.....	14.00	15.80	57.20
G without nitrogen	.....	.....	.....	5.00	1.50	6.50	10.00	3.00	20.00	60.50
G without nitrogen No. 2	.....	.....	.....	12.00	2.00	14.00	5.00	1.50	20.00	59.50

† *Journal des Fabricants de Sucre*, 1878, October 13.

nitrogenous manures of organic origin. In fact the first are at once absorbed by the young plant favoring the development of leaves. On the contrary, the others act slowly and in decomposing may undergo nitric fermentation, which, favored by meteorological conditions, such as probably existed in 1875 to 1876, creates in the soil an abundance of nitrates, the retarding action of which impoverishes the root in the last days of growth.

Concerning stable-manure, it is a fact that there is no necessity for prohibiting its use, because growers are generally wanting in it, and they will not be tempted to use it in excessive quantity to the same extent as they may be induced to use the mineral manures. But it is useful to show that this excessive use, if it were possible, would be even more fatal than the use of nitrates, as regards the quality of the root.

3. For the same reason the use of nitrates after sowing, and especially in the months of August and September, is absolutely bad, and may be characterized as fraudulent.

4. The abuse of nitrogenous manures, nitrates, and others is much less fatal when used upon rich varieties, and roots closely planted than upon poor varieties and roots cultivated at greater distances.

5. The causes to which the bad quality of the beets in our region (department of Pas-de-Calais) should be attributed are * * * the too great richness of our soils in nitrogenous matters, the abuse of manures, and the application of nitrates after sowing.

Concerning stable-manures and the other nitrogenous manures used, M. Georges,* in a lecture on beet-root culture, advises that the quantity of stable-manure should not exceed 10 to 15 tons per acre, since this quantity will supply sufficient of salts for the needs of the plant. Nitrogen, being the deficient constituent, should be supplied by some very soluble and easily-assimilable compound, such as from 250 to 350 pounds per acre of nitrate of soda, with an addition of a like quantity of superphosphate of lime, the latter element especially intervening to increase the richness in sugar. The prejudice against nitrate of soda is unjust. Judiciously applied it is useful. Only its abuse is disastrous, but neither more nor less than the excessive use of all others, and even stable-manure worked into the soil previous to sowing; it hastens the vegetation of the plant at the start and helps it through the first stages of growth. When it is exhausted, the stable-manures, by their slow decomposition, supply the subsequent demands of the plant. But nitrate of soda should not be applied during the growth of the plant, because it may then remain in nature in the adult beet, which will not have time to elaborate it and secure all the useful effect. Sulphate of ammonia, with an equal quantity of nitrogen, seems to be less favorable than nitrate of soda, because it is a salt which tends to rise to the surface in the soil, while the other descends to an equal extent. Other matters, such as seed-cakes, woolen wastes, &c., may be substituted for the nitrates, but they should in all cases be worked into the soil before sowing, that they may have time to decompose in advance and may be thoroughly mixed through the entire arable stratum.

These ideas expressed by M. Georges were reiterated by M. Drouyn de l'Huys,† and express the views of all scientists and cultivators in

* *La Sucrerie Indigène*, 1878.

† *Compte-rendu des Séances du Congrès Agricole et Sucrière tenu à Compiègne, Mai*, 1877.

France. But while all admit the value of the judicious application of the nitrates, it appears also to be the universal opinion that it should be accompanied by the application of a corresponding quantity of the phosphates, which have a tendency to counteract any prejudicial influence that the nitrates may exert by hastening the maturity of the plant and increasing its sugar content. This fact has been very nicely elaborated by Professor Maercker, of Halle, in a lecture lately delivered upon the subject of beet culture, an abstract of which may be found in the *Journal des Fabricants de Sucre.* He says it is a well-accepted fact that strong doses of nitrogenous manures are injurious to the beet crop, in that it increases the weight of the non-saccharine contents and reduces the sugar. The discredit into which the use of nitrates has fallen is due to its abuse and the manner of applying it. The difficulty appeared to be to determine the quantity to use and the best time to apply it. When applied too late it retards ripening. Applied in spring the plants develop vigorously in leaves and root and the period of growth is lengthened. So strongly nitrogenous manures always produce growth.

But the sugar-beet must ripen to accumulate sugar within it. Its growth should therefore be arrested to admit of ripening, which late distribution of nitrates prevents. At Magdeburg part is applied in the fall and the remainder before the preparation of the soil in spring. Heavy doses of strongly nitrogenous manures also necessitate heavy doses of phosphoric acid to annihilate the injurious effect of an excess of nitrogen. Phosphoric acid applied in large quantity induces early ripening of the plant. A mellow, permeable, clay soil may receive doses that would be injurious to a cold soil.

Pagnoul has developed by his researches and observations that phosphoric acid gives varying results. In some soils no appreciable effect can be noticed, while in others its use has been found very favorable, and these differences are attributed to the greater or less proportion of phosphoric acid already existing in the soil. Notes should therefore be kept of the effects of various manures in order to avoid unnecessary expense in their application. M. Decrombecque considers that in all cases the phosphoric acid in the soil should be increased as the nitrogenous principles increase, and Woussen considers phosphoric acid a corrective for the deleterious influences of nitrates, because upon soils where nitrate of soda has been applied in large doses it is only necessary to increase the proportion of phosphates of lime to secure good maturation of the crop, which would otherwise remain green.

Pellet* has advanced some interesting notions concerning the comparative values of the different elements of plant-food in their relation to the production of sugar in the beet, deduced from the study of analyses of different plants obtained by various persons in their experiments. Lawes and Gilbert, discussing the analyses of wheats grown upon the Rothamstead farm, and of French wheats analyzed by Bous-

* *Journal des Fabricants de Sucre,* October 2, 1878.

singault, conclude that wheat scarcely admits of a change in the composition of its ashes, whatever may be the composition of the fertilizers applied; the same is true of potatoes.

But Pellet finds that the beet, on the contrary, may grow with equivalent substitutions of the alkaliles necessary to the formation of sugar, so that, as shown by the experiments of Joulie, soda may be found in the ash of some beets in the same quantity as potash, while in others the quantity of potash is seven times that of soda. This substitution may also be noticed between lime and potash, but experience shows that though the alkalies may thus substitute each other, and lime, by equivalents, certain other bodies, such as phosphoric acid, will not admit of being replaced. The experiments of Champion and Pellet also show that in all plants we may observe a relation between the total weight of ashes and the special organic matters for which the plant is cultivated. Thus, in wheat between the starch and total ash, and in the beet between the sugar and total ash. They construct the following table, showing in general that for the formation of 100 pounds of sugar in beets, the roots and leaves in their development must consume—

1 to 1.20 pounds of phosphoric acid.
5 to 6 pounds of potash.
1.5 to 2 pounds of soda.
1.5 to 1.6 pounds of lime.
1.2 to 1.4 pounds of magnesia.
2.7 to 3.5 pounds of nitrogen.

Excess of all may be present in the soil, but if phosphoric acid be wanting sugar will not be produced, while if lime is wanting it will be replaced by potash or soda or magnesia, and this rule holds good for the other alkalies. The author therefore concludes that 1 of phosphoric acid corresponds to 100 of sugar, while 5 to 6 of potash corresponds to the same amount, and consequently phosphoric is worth 5 or 6 times more than potash in the formation of sugar, if potash replaces no other alkalies; in other words, if a soil be wanting in 60 pounds of assimilable potash per acre, there will be a deficit of 1,000 pounds of sugar, while for the same deficit only 10 pounds of assimilable phosphoric acid need be wanting. Phosphoric acid he considers a non-dominant but indispensable element or base for the formation of sugar in the beet.

Reasoning from these data, they conclude that without experiment, but by examination of the average composition of the ashes and of the quantity of nitrogen in the plant, and comparing the total weight of the different constituents with that of the given proximate principle to be produced, for instance, sugar in the beet and starch in wheat and potatoes, it is possible, they say, to determine the order in which the elements of plant-food are indispensable for each plant. Thus, for the beet they range: 1, phosphoric acid; 2, lime or magnesia; 3, nitrogen; 4, potash or soda. On the other hand, the order for wheat is: 1, lime or magnesia; 2, potash; 3, phosphoric acid, &c. These are facts of great importance

in the economy of providing supplies of plant-food, and they will aid greatly in the selection of the compounds to be employed for the fertilization of various crops.

From what precedes and what we learn from the long-established practices followed in France in the application of fertilizers to the land on which beets are to be produced, it appears that nitrogenous organic compounds insoluble in water should be worked into the soil a long time in advance of the crop, and that to enjoy a beneficial result from their use they should be distributed at least during the autumn preceding the season of planting, and for stable-manures it is preferable that they be given to a preceding crop, which in France is generally oats or potatoes.

Stohmann,* says it is generally recognized as a rule that the sugar-beet should never be cultivated upon a fresh manure or barnyard manure, because this system of culture gives a large yield in weight, but roots so rich in foreign matters that they cannot be worked with profit. The beet should always form the second rotation when the manure is strong.

Other organic nitrogenous compounds, such as seed cakes, refuse animal matters, and even ammonia salts, may be applied in the fall or in the very early spring, while the nitrates, which are more soluble, may be applied either immediately before or immediately after planting.

In no case should the latter be applied during the period of growth, on account of its influence as shown by numerous experiments, to retard the time of ripening and the consequent maximum development of sugar.

The quantity of stable-manure per acre that may be applied to land to produce the most favorable effect seems in France to be from 8 to 15 tons, according to the character of the soil, and it is generally more profitable to use a smaller quantity and supplement it with nitrates and phosphates. The value of lime in its relations to the beet is no less than for other crops. Its disintegrating influence upon the nitrogenous organic matters is as important as its power to take the place of other alkalies which may be wanting. In fact, on account of this property, many of the most intelligent growers are inclined to use it, and by means of it to avoid in the juice many of the more objectionable soluble salts that the alkalies are likely to introduce. Another important consideration is its low market value, and the convenience of its application. At the same time, deficiencies of the other alkalies in the soil should not be overlooked, and they should be in all cases made up.

It is scarcely necessary to further call attention to the importance and value of the phosphates in connection with this crop, after all that has been said. They may be applied at all times, and many growers consider it of advantage to distribute small quantities with each working or hoeing. The general method employed, however, is to distribute it in advance of the last plowing, in the course of which latter operation it becomes distributed throughout the entire arable layer. But if ap-

* *Journal des Fabricants de Sucre*, November 20, 1878.

plied in the spring, it is considered by many that it should be deposited in the rows with the seed, and M. Derome is of the opinion that 100 to 250 pounds per acre applied in the rows will produce quite as good effects as 400 to 800 applied broadcast. He concludes from all his experiments, the results of which are confirmed by those obtained by Corenwinder, Pagnoul, Ladureau, and others, that artificial fertilizers worked in with the plow will give an average of about 3 tons more of beets than the same quantity of manure applied on the surface and worked in with the cultivators.

The next consideration in the culture of the beet is the improvement of the physical qualities of the soil, and its preparation for the crop. The importance of drainage, &c., has already been referred to in the review of the inherent physical qualities of the soil which make it suited to this crop, and we may therefore proceed at once to the consideration of its manipulation to bring it to the favorable conditions before quoted. And we shall first of all review the ideas advanced on this subject by some of the later writers who may be considered good authorities. Briem* says:

> The development of the beet depends, in the first place, upon good preparation of the soil, and its continued and careful maintenance. A preparation carefully effected brings about a mellowing of the soil, access and change of air and water, destruction of weeds, and deep growth of the root. Deep plowing (with steam where this is possible) is the first condition of a rational culture. This operation should be effected in advance of winter. Subsequent cultivation should not be spared. It improves the size and quality of the plant, and should be repeated as often and as long as the leaves will permit. The more the culture approaches that of a garden, the more the quantitative and qualitative yield will be increased.

According to Stohmann, beets do better after well-manured graminæ. They naturally find place in rotation after wheat or barley. In some cases beets have been produced two years in succession, but this is possible only in exceptional cases. It is injudicious to recommend a rotation of beets of less than two years. Immediately after a crop of cereals, the ground is broken up. In the fall, plow as deeply as the nature of the soil will permit, and leave the field with the furrows thus exposed during the winter to atmospheric influences. In the spring, prepare the soil for sowing by means of the roller and harrow; and in order not to lose the accumulated moisture of winter, avoid, as far as possible, plowing again in the spring.

Vilmorin† directs to begin with an ordinary plow in the fall, followed by a draining plow, so that the ground will be broken up to a depth of 6 to 8 inches; and plow in the spring, and follow with harrow and roller. We cannot more clearly give the prevailing opinions of French growers upon this matter of preparation of the soil than is expressed in the discussion on the subject in the meetings of the agricultural and sugar congress held at Compiègne in May, 1877, and published in the

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* *Journal des Fabricants de Sucre*, October 23, 1878.

† *Journal des Fabricants de Sucre*, February 27, 1878.

report of the proceedings; and I therefore present below a translation thereof:

M. Boursier said that it is, above all, necessary to work the ground and put it in such condition that it may be at the same time permeable and firm enough to adhere to the roots. This is effected by deep plowing, and energetic harrowing and rolling. It would, nevertheless, be useful to elucidate this point, whether it is better to give a single deep plowing in autumn, followed by cultures with the scarifier and the harrow in spring, or to give several plowings, the first in advance of winter and the second immediately preceding sowing. For himself he considered it better to give a single deep plowing in the fall or winter.

M. Debains prefers the system which consists in first giving a plowing to break up the stubble, followed by another to bury the manure, and finally a third before sowing.

M. Blin said there was no necessity to have an absolute system with this regard. It would be dangerous to give a deep plowing to land having a shallow stratum of arable soil.

M. Decrombecque had not adopted deep plowing, for the nature of his soils would not permit it; but in order to submit the greatest possible surface of soil to the beneficial atmospheric influences, he practiced the method of ridging.

M. Boursier explained that by deep plowing he did not mean absolutely to say 14 to 16 inches; plowing is considered deep when it exceeds by 1 or 2 inches that of preceding culture. A plowing of 10 inches would be deep in ground which had never been broken up more than 8 inches; the depth is modified according to the soil.

M. Demot called attention to the excellent effects of breaking up without displacing the subsoil (*i. e.*, subsoiling). With this system the production is sensibly increased. The use of the draining plow should be strongly recommended.

M. le. Vte. de Chezelle called attention to the favorable effect of deep plowing shown by the vegetation on the sides of ditches opened for drainage.

M. X. ——— responded that this fact does not constitue an argument in favor of deep plowing. In fact, in drainage the vegetal earth is always returned to the top, while plowing brings the subsoil to the surface, and if this is not vegetal (fertile) it is evident that the operation is defective. He also insisted upon the use of the draining plow.

M. Barral recognized the fact that deepening the arable layer is always advantageous in the long run, and he recommended attacking the subsoil only with precaution, and after taking into account its chemical composition. In this connection, as in the most of agricultural questions, it is impossible to fix an absolute principle, and it is always necessary to take account of circumstances. Besides it cannot be denied that the beet is one of the plants for which the depth of the arable layer is of the greatest importance.

M. de Rougé has proven the excellent effects of deep plowing upon the poor clay soils of the extremity of the Aisne. Like M. Boursier, he counseled plowing in autumn. During the winter the land to be sown in the spring should be impregnated with the substances of the air and submitted to the favorable atmospheric influences. Broad furrows should be made in the first plowings given in autumn, because the more the earth is formed of large lumps, the more the frost may penetrate by the wide spaces which separate them.

M. Ch. Gossin remarks two unfortunate effects in the plowing which immediately precedes sowing the beet. 1. This plowing stirs up the soil in the interior. Now, the beet does not like light soils. 2. By this plowing we bring to the surface a quantity of bad seeds, which germinate at the same time as the beet, and cover the ground with weeds, while if the ground be plowed in the fall, the seeds which germinate in the early spring are killed in the operations of culture which precede sowing. Therefore in the triple regard of contact, of atmospheric agents, of the mellowness and internal cohesion of the soil and cleanliness of the ground, fall or winter plowing should be advised.

The method of preparation followed in practice by M. H. Vilmorin is as follows: Begin plowing in November and break up the land eight or ten inches, and follow this with a subsoil plowing to a depth of eight or ten inches more, so that the ground will be thoroughly stirred up to a total depth of at least fifteen inches. During the progress of this work, and as far as possible, the artificial fertilizer employed is distributed in the furrows before subsoiling. The ground is then left in the rough condition consequent upon plowing, and after that is twice plowed in spring, in February and April. It is finally prepared for sowing by harrowing and rolling.

M. Champonnois considers it of advantage to prepare the ground in ridges before sowing, especially in working very shallow soils, in order to provide depth for the long tapering root, and put the ground in better condition for the circulation of air and water. He claims for his method of culture that it is less costly than the ordinary method, and gives a better quantitative and qualitative result. In his experiments he obtained forty tons of beets per acre having an average richness of 18.50 per cent. and a coefficient of purity above 83.

The results of his experiments in 1878 do not seem to be as good as those obtained in previous years, as shown by the following table:

	No. 1.	No. 2.	No. 3.	No. 4.
Product per acre (tons)	28,300	40,450	22,500	11,725
Density of juice	6°.17	5°.45	6°.75	7°.5
Per cent. of sugar	11.37	9.61	14.90	16.91
Quotient of purity	69.70	66.69	83.94	86.0

OBSERVATIONS.

No. 1.	No. 2.	No. 3.	No. 4.
Seed, four kinds; richest, 12½ per square meter; fresh manure two months before sowing; earth beaten slightly on April 23, and after the beets had four leaves; complete manure, 200 pounds per hectare; culture given regularly.	Same culture and care; four kinds of seeds productive of weight; at November 1 beets were in full growth due to kind of manure and time of its application; beets short and rooty.	Manure well rotted; plowed in ridges; well beaten by rolling; manure-residues of elution containing salts and nitrogen of molasses; culture regular thro'out entire growth.	No manure plowed in; chemical manure, 625 pounds per acre, worked in; sowed late; culture continued throughout vegetation; quality good; quantity wanting, explained by late sowing.

However, in this matter of preparing the soil, as in all others, it appears that the grower, while following the general principles enunciated, must be guided by his own judgment and the character of the soil with which he has to deal.

Sowing is generally effected by means of a drill especially designed therefor, but any drill that will deliver the seed regularly and in sufficient quantity will satisfy every purpose. The forms employed in France vary with the different inventions, but the spoon drill is the most common.

The best time for sowing is considered to be the last week in April and the first fortnight in May, when the temperature should range from 50° to 60° Fahr., for at this temperature the seed will germinate most surely and most rapidly. The germinating faculty is materially increased by immersing it in water at 120° Fahr., and the beets produced are often richer in sugar on account of this treatment.

Messrs. Champion and Pellet* give the following results of an experiment in growing seeds soaked in water and those not soaked:

	Date.	Average weight.	Per cent. sugar in beets.
		Grams.	
No. 1, normal seed	August 31	400	16.4
	September 16	460	13.4
	September 29	580	17.0
No. 2, soaked seed	August 31		16.9
	September 16	500	14.9
	September 29	580	17.2

Besides this, the beets produced with soaked seed had a better form than those from normal seeds.

Various solutions have been suggested to be employed for soaking the seed, among others water slightly acidulated with nitric acid. Humboldt suggested very dilute chlorine water, but Duchartre showed that this was of no value.

In many sections of France and Germany the juices flowing from the manure heaps are used for this purpose. They are diluted with an equal volume of water, and the seeds immersed in them for 48 hours. The seeds are after this time taken out, mixed with ashes, and passed over a screen. After this treatment they may be put in bags and kept in a cellar or other cool place until needed. When ready to be sown they must be quite dry on the surface, in order that they may not adhere to each other in sowing. Other solutions for the purpose have been used in France and Germany, the values of which, Basset† states, range in the order in which they are named:

1. Mixture of urine and water in equal parts.
2. *Purin*, or manure juices, pure or dilute, for which may be substituted ordinary water in which has been macerated guano, fowls' or pigeons' dung, so as to obtain a solution of a density of 1.015 or 1.020.
3. Solution of nitrate of potash of 5 per cent.
4. Solution of phosphate of ammonia of 2° B.
5. Solution of superphosphate of lime 2 per cent.
6. Solution of 2 to 2.5 parts chloride of lime in 100 of water.
7. Dilute acid solutions of 1 to 1½ per cent., prepared only with hydrochloric, sulphuric, or phosphoric acids.

* *La Betrave à Sucre.*

† *Guide Pratique du Fabricant de Sucre.*

Solutions of nutritive matters are considered more favorable to the purpose than pure water, because the latter in prolonged soaking will often remove from the seeds some of their soluble constituents. The length of time during which the soaking should be continued might vary somewhat, according to the temperature, but it is generally confined to 48 hours, and 24 are often considered sufficient. Basset states that during 24 hours seeds will absorb—

69 per cent. their weight of water at 39.9° Fahr.
91 per cent. their weight of water at 50.8° Fahr.
95 per cent. their weight of water at 60° Fahr.
97 per cent. their weight of water at 65° Fahr.

Experiment has shown that seeds require, in a soil sufficiently moist and aerated, a total sum of degrees of average temperatures equal to 650 Fahr. for germination. Thus if the average daily temperature be 50°, 13 days will be required for germination; if it be 55°, then 12 days will suffice; and if 65°, only 10 days will be required. If, however, the seed be soaked for 24 hours in water at 100°, then the total sum of thermometric degrees, and consequently the number of days required for germination, will be correspondingly reduced. If they be soaked 48 hours at 100°, then only 9 days will be required for germination in the ground at an average temperature of 50°, and a correspondingly less time with a higher temperature.

With regard to the best time for sowing them, Basset* directs as a rule: "*Sow as early as possible according to the temperature of your locality, whatever may otherwise be the method chosen.*" Thus, when the temperature of the air is from 50° to 54° Fahr. at noon, 46° to 50° in the evening, and 32° to 36° in the morning, sowing may be begun without fear of unfavorable temperature. This may be combined with observations of the temperature of the soil, which should at the same time have an average of about 45° at a depth of 4 to 6 inches.

Concerning the depth to which the seed should be covered in the ground, opinions differ somewhat, but it will naturally follow that much must necessarily depend upon the temperature of the season, the physical condition of the soil, and the proportion of moisture. The seed requires the presence of oxygen for germination, and, therefore, if the penetration and circulation of atmospheric air be rendered difficult or impossible on account of a close, hard character of the soil, this function cannot be exercised, and the seed will rot in the ground. If the soil be permeable and contain sufficient moisture, the depth of covering the seed will vary with the temperature. If this be too low, again, the seed will rot. But with a favorable temperature and a good physical condition of the soil, less attention may be given to the depth of seeding. However, it is considered a good rule not to bury the seed under any circumstances more than 1 to 2 inches, and experience has shown

* *Guide Pratique du Fabricant de Sucre*, p. 387.

that at this depth, other things being equal, a higher percentage of the seeds will grow than at any other.

In all of the beet-growing districts of Europe the system of planting in rows has been adopted, but in later years the attention and experiments of the progressive men have been directed to the determination of the influence of the distance between the rows and the beets in the rows upon the yield per acre and the saccharine value of the crops. In earlier years the practice was to separate the roots to such an extent that each square yard of surface should be devoted to six roots, but the experience of later years has shown that it is better to increase the number for this surface to ten. The extent of separation must naturally vary with the character of the soil and the seed grown. If in rich soils the roots be widely separated from each other they have at their disposition more of nutritive materials, and there is, of course, a tendency to the production of large roots, which, we have seen, will contain more of mineral and organic impurities and less of sugar. On the other hand, if grown more closely the stock of nutriment is less, the beets are smaller and longer, and consequently richer. Yet, notwithstanding the smaller volume of the beet produced, the weight of the total yield per acre is very much larger than when the roots are separated to greater distances. These facts are amply illustrated in the results of the experiments of various workers in the sugar-growing districts of France.

The following table shows the averages of the results obtained from experiments made by the *Société d'Agriculture de Compiégne* in concert with the *Comité des Fabricants de Sucre de l'Oise.* This recapitulation is made simply according to the separation, and without regard to the fertilizers employed.

[Distance between the rows, 18 inches.]

Distance between beets in the rows.	Tons of beets per acre.	Average weight of a beet.	Density of pure juice.	Per hundred of juice.			Degree of purity.	Saline coefficient.	Pounds of sugar per acre.
				Sugar.	Salts.	Organic matters.			
		Lbs.	°						
Ten inches	32.533	1.88	6.79	14.55	1.0823	2.0910	81.93	13.58	8,473
Fourteen inches	29.515	2.23	6.06	12.68	0.8195	2.2976	80.19	15.61	7,480
Eighteen inches	31.048	2.85	5.05	12.40	0.8700	1.0142	86.71	14.43	6,691

Pagnoul's experiments, conducted during a series of eight years, gave similar results. He concludes that close planting gives beets which are, 1, richer; 2, better quality; 3, of larger yield in weight; 4, less exhausting to the soil. He took, for his wider separation, 20 inches between the rows and 20 inches between the roots in the rows, and for the smaller separation 17 inches between the rows and 8 inches in the rows.

1. The richness of sugar in percentages of the weight of root was:

For the large distances 10.2
For the small distances 12.2

2. The proportion of alkaline salts, giving at the same time the measure of the foreign organic matters, was for 100 of beet:

With large distances	1.512
With small distances	0.722

3. With large distances there were 16,326 roots per acre, and with the small distances 46,122, or nearly triple. The yield in weight per acre was:

	Tons.
With large distances	28.035
With small distances	36.045

4. The quantity of salts removed per acre would be equal in round numbers to:

	Pounds.
With large distances	840
With small distances	520

M. Pagnoul says, in conclusion:

Beets at small distances, while producing more of sugar, absorb less of saline matters.

Now we know that the constituent principles of sugar are entirely furnished by the atmosphere, and that the saline matters are furnished by the soil and by fertilizers; therefore, *beets at small distances from each other* (*i. e.*, closely planted) *are less exhausting to the soil.*

Close culture is more profitable at the same time to the grower and the manufacturer.

Dubrunfant says:*

The multiplication of subjects to avoid large roots, and to facilitate at the same time the production of a good constitution of the cellular tissue, is another condition to which great importance should be attached in the interest of richness in sugar.

Briem says† "the separation of the roots should be 15 by 10 inches."

In a late discussion in the meeting of the *Cercle Agricole du Pas-de-Calais*,‡ it was developed that though the distance of 17 inches between the rows was still in use, it is gradually giving way to the wider separation of 20 inches, on account of the difficulties experienced in horse-hoeing and the deficient aeration of the improved races of beets with strong foliage, which require more room.

At the same time that the wider distance between the rows is adopted, the roots are left closer to each other in the row about 8 inches; that is, to confine them to from 7 to 9 roots to the square yard of surface.

The experiments of M. Pagnoul, and results he obtained, together with the other facts and figures given, will be sufficient to show the importance of this matter of close planting, without quoting the results of the same character obtained by Corenwinder, Ladureau, Mariage, Pellet, Deherain, Vilmorin, and others; and we may conclude that for the methods of culture that must be employed in the United States, where hand labor cannot be obtained, the wider distance between the rows, 20 inches, should be adopted, separating the roots not more than 8 inches in the rows.

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* *La Sucrerie Indigène*, xiii, 460.

† *Journal des Fabricants de Sucre*, October 23, 1878.

‡ *Journal des Fabricants de Sucre*, June 4, 1879.

The cultural manipulations proper of the crop should begin as soon as the beets are up and the leaves sufficiently developed to distinguish the rows; and we may accept the statement so universally reiterated by those who speak and those who write on the subject, as supported by the success of the practice, that "early and frequent cultivation cannot be too strongly recommended; it kills weeds scarcely started and forms a stratum of mellow earth which constitutes an obstacle to dryness by day and assimilates the moisture of the night."

As before stated, as soon as the rows are defined by the development of leaves the first cultivation by hoeing begins.

In France this is, in many sections, performed by hand, while in others it is effected by means of the horse cultivator, the object being, of course, the destruction of weeds and stirring up the soil. At this time, also, many growers make an application of nitrate of soda or potash. Two weeks later the beets are thinned out, so as to leave the roots about 8 inches apart from center to center, after the manner described above. After this the crop receives about three hoeings or cultivations, and more than this if time allows, for the work should be discontinued about the 1st of July, according to some authorities, or it may be continued as long as the leaves will allow, according to others. The latter will probably be for all localities and climates the better indication.

After the final hoeing, about the 1st of July, no other care is necessary, with the exception of the removal of seed-stalks that may occasionally appear, especially if July and August be dry, until the harvesting, which should take place before the appearance of hard frost. If the roots be frosted in the ground they are rendered unfit for storing and preservation in caves or trenches for extraction of the sugar in the late winter, which is of course often necessary.

Harvesting is generally begun about the middle of September, and may, according to the condition of maturity of the crop, continue until the middle of October.

Pulling the roots is sometimes effected by machines that have been devised for the purpose, but the method generally employed is hand-pulling; the latter facilitated by the assistance of the pick or plow. In many cases a narrow furrow is made near to the row, which loosens the earth about the root and renders its extraction from the ground easier. The operation must in all cases be exercised with great care, in order that the roots be not bruised or cut, accidents which increase the tendency of roots to decay when stored. They should also be pulled when the ground is in the driest condition. If the ground be wet at the time of pulling, the earth will adhere to the root, and this will also produce a tendency to decay. Besides this, trouble will arise in the determination of the tare in the delivery of the crop to the manufacturer. In most cases the leaves are removed from the beet in the field, either at the time of pulling or at the time of charging them to the carts or wagons in which they are to be transported, either directly to the factory or to storage. If there be danger from frost the roots are piled in

pyramidal heaps, either before or after the removal of the leaves, in such a manner that they may be covered by their leaves or by straw. The leaves are removed by a knife or other instrument sufficiently strong and heavy that the operation may be effected at a single stroke. It is estimated that 20 laborers* (women and children) will be required to pull and prepare for transportation from the field the crop of an acre of beets in one day.

But this estimate is made for French laborers, and we may calculate that only half the number of laborers will be required in the United States to do the same amount of work.

The beets to be preserved, if all surface moisture has not already evaporated from them, should, before being placed in trenches or cellars, be temporarily stored under sheds. Here the wounded, withered, or frosted roots, which would be subject to rot, are separated ,if they have not already been in the field. The larger roots are also separated for the same reason. When thus separated and prepared they are ready to be stored. In the preservation the conditions to be avoided are too low or too high a temperature, too moist or too dry an atmosphere. With too low a temperature they deteriorate by freezing. This is not so injurious if the roots can be worked before they have an opportunity to thaw; otherwise, much of the cane-sugar changes over to inverted sugar, and must necessarily pass into the wastes in the processes of extraction. If too warm, similar effects will be produced by growth of leaves, as shown by Corenwinder and others. If too much moisture be present the roots have a tendency to rot, and if too little be present there will be a tendency to wither, and this effect is always accompanied by a loss of sugar, besides increasing the difficulty of extracting the juice from the root.

The best temperature for preserving the roots in the fresh state, which is the condition of preservation most employed in France, is between 35° and 40° Fahr. The equilibrium of moisture between the air and the root should be so maintained that evaporation may not take place; at the same time, as before stated, excess of moisture must be scrupulously avoided. Prudent cultivators consider that the roots should be so arranged in storage that they shall never be more than three feet from an air passage, in order to secure constant and regular renewal of the air to carry off noxious gasses, superfluous moisture, and regulate the temperature which always has a tendency to rise. The cellars or trenches must also be thoroughly drained, so that any water that may collect in the bottom may flow off. Temporary trenches are often made in the fields, but the more advanced growers are preparing permanent ones with well-paved bottoms and walled sides. They are generally 8 to 10 feet wide and 6 to 8 feet deep. I have seen them with walled sides 9 by 9 by 35 feet.

*In the department of Seine-Inférieure 10 laborers are generally employed for pulling the crop and preparing for transportation, 5 to pull the roots and 5 to remove the leaves and tops.

Along the bottom of the ditch and through the middle of it is made a small trench to convey any water that may percolate through the walls or through the roots. Before the beets are placed in the trench the bottom is covered with poles, or in any other convenient manner, to keep the roots off the bottom and provided for free circulation of air under them and drainage of water. Straw is often used for this purpose, but is considered bad because it is subject to packing and decay, and the latter will, of course, be communicated to the stored roots. They are then packed in the trench and covered with straw or leaves and finally with earth. The depth of covering must be determined by the climate. In the case of permanent walled trenches, which amount in reality to elongated cellars, I have seen them covered with a very thick thatch of straw, proper openings being provided for the necessary ventilation. In this way the roots may be preserved throughout the entire winter. If they should by accident be frozen they should be preserved in this condition until they are worked. Indeed this condition constitutes one of the modes of preserving them where a sufficiently low temperature may be maintained to keep them in this way unchanged without an opportunity for thawing, and is recommended by some authorities. In sections where excessively cold winters prevail it might be found a very convenient method for the purpose.

Desiccation may be practiced where the method of diffusion or maceration has been adopted as the means of extracting the juice. It has the advantage of preserving the beet perfectly, with no danger from variations of temperature if the product be kept free from moisture or a moist atmosphere. They are also in the most favorable condition for ready transportation to any distance.

For the purpose of drying, the roots are cut in slices, and in warmer climates placed in the sun, but in ordinary climates they are dried in ovens by artificial heat. The method has the disadvantage of requiring a double expenditure of fuel in evaporation, *i. e.*, for the removal of the water of vegetation and the water of diffusion employed for extraction of sugar.

We see therefore that the experience of French growers and scientists proves that to secure the greatest profit from the culture of the beet the following points must be observed:

Choose well-drained permeable soils, not overcharged with nitrogenous organic or soluble mineral matters. Choose the best qualities of seed. Give preference to smaller seeds. The best beets for all purposes are long, tapering, and smooth; do not grow out of the ground; are of moderate size and are dense and heavy. Plow deeply and as frequently as may be necessary to make the soil mellow. The more it approaches that of a garden in physical condition the more favorable it will be for culture of the beet.

Be careful in choice of manures to be employed. Remember that insoluble and not easily assimilable nitrogenous organic compounds, before they can be of use to the crop, must be thoroughly disintegrated

and decomposed. They must therefore be applied sufficiently in advance of the crops to secure this effect. Soluble nitrogenous compounds may be applied immediately in advance of or simultaneously with planting, and of these the nitrates are preferable. Nitrogenous compounds have a tendency to extend the period of growth and delay the time of ripening. This tendency is counteracted by the phosphates, in consequence of which they increase the production of sugar.

Stable manures must in all cases be worked into the soil with the fall plowing. Do not apply more than 10 to 15 tons per acre, and supplement it with nitrate of soda and superphosphate of lime at the rate of from 200 to 400 pounds of each per acre, according to the character of the soil.

Alkaline salts should be applied with great caution, and only to soils manifestly wanting them. They add to the cost of culture, and often reduce the industrial value of the crop. Plant closely; 18 to 20 inches between the rows will be found the most convenient and favorable for culture in the United States. Separate the beets by about 8 inches in the row.

Cultivate early and often, and continue as long as the leaves will permit, but not longer than the middle of July. Do not harvest until the crop is thoroughly ripe, but it must not be allowed to be injured by frost.

Store the roots in such a way that they may be protected from extremes of temperature and moisture, and observe care in ventilating trenches or cellars; otherwise the roots will rapidly deteriorate.

CHAPTER VI.

SOCIAL CONDITIONS AFFECTING BEET-ROOT CULTURE.

It is rather difficult to determine to what extent existing social conditions and habits of a people may affect the profitable operation of an industry in the different countries, as based upon the density of population, the percentage thereof engaged in active work of production, whether of employers or employed, in the factories or on the farms. While it is true that there must be a sufficient abundance of laborers in the population of a section to satisfy the demands made by the manufacturing processes, it is also true of the industry of production of sugar from the beet that it provides work throughout the entire year, in the factory in the winter, when laborers on the farms are comparatively idle, and employment in the summer in the cultivation of the crop.

The following table, showing the population of the different departments of France engaged in agricultural work, serves to illustrate the difficulty of determining from this source any special influence upon the extension of this valuable industry. The table is nevertheless of interest, and will explain itself:

Detailed statistics of population

Departments.	1.—Individuals cultivating their own lands.							
	Proprietors.		Clerks or employés.		Laborers.		Day laborers.	
	Men.	Women.	Men.	Women.	Men.	Women.	Men.	Women.
Ain	40,070	3,670	656	399	2,137	1,266	3,001	2,271
Aisne	14,326	1,855	918	585	7,197	3,979	11,291	8,887
Allier	20,350	3,168	303	120	1,583	1,010	3,623	2,753
Alpes (Basses)	19,686	2,560	268	214	478	528	2,337	1,163
Alpes (Hautes)	22,535	2,164	61	7	472	322	814	275
Alpes-Maritimes	5,827	400	540	290	2,840	1,140	1,320	840
Ardèche	42,441	2,613	1,193	1,358	7,501	1,118	3,339	2,157
Ardennes	11,974	1,746	195	83	1,986	1,124	6,975	3,847
Ariége	29,958	3,844	214	151	2,062	1,832	2,326	1,718
Aube	15,697	2,371	391	52	1,519	1,732	2,201	3,582
Aude	17,375	4,435	650	762	9,494	1,509	21,272	15,364
Aveyron	51,492	2,096	70	5	6,523	3,277	8,219	3,190
Bouches-du-Rhône	17,684	2,705	389	135	1,275	365	6,097	2,723
Calvados	17,537	2,746	463	563	3,147	2,667	8,588	5,096
Cantal	24,598	3,317	1,961	1,009	2,291	1,002	3,402	3,835
Charente	41,495	3,920	337	145	1,985	579	2,776	1,701
Charente Inférieure	51,630	3,536	400	100	4,302	4,621	4,153	4,240
Cher	16,109	1,784	574	56	7,035	5,026	21,660	15,976
Corrèze	35,082	4,999	115	25	3,000	1,500	3,982	2,151
Corse	19,572	2,484	106	41	4,452	3,903	10,576	11,218
Côte d'Or	8,855	999	186	46	1,296	407	3,041	1,932
Côtes-du-Nord	30,235	4,714	208	137	3,783	3,034	9,233	8,096
Creuse	3,702	802	280	281	1,547	540	1,483	553
Dordogne	49,470	87	1,240	101	1,410	1,520	10,170	1,250
Doubs	19,104	2,160	303	280	1,790	2,064	1,783	1,551
Drôme	42,151	4,093	291	271	1,742	1,583	3,393	3,345
Eure	14,969	2,348	753	729	2,616	1,831	4,773	2,555
Eure-et-Loir	9,870	2,959	333	125	1,573	1,440	4,037	3,006
Finistère	18,443	1,570	435	431	5,039	2,810	8,070	4,659
Gard	30,158	2,887	661	154	2,676	706	6,940	2,388
Garonne (Haute)	28,763	2,549	2,000	100	5,189	2,073	9,227	8,320
Gers	33,818	3,152	304	450	2,710	2,503	3,597	3,858
Gironde	47,022	6,670	1,196	603	3,739	3,803	7,046	9,161
Hérault	18,521	1,752	702	566	3,649	2,045	4,500	4,810
Ille-et-Vilaine	25,553	3,942	50	3	3,822	2,681	6,818	5,789
Indre	14,217	3,880	328	315	1,749	840	5,059	2,430
Indre-et-Loire	6,440	1,474	366	467	608	461	2,019	1,757
Isère	63,244	3,203	1,590	1,707	3,329	3,446	8,506	6,399
Jura	26,331	3,042	195	436	1,062	969	1,736	1,593
Landes	8,702	1,428	235	240	1,124	856	1,418	1,544
Loir-et-Cher	11,258	2,242	165	61	679	364	1,947	1,005
Loire	20,817	2,736	472	157	10,103	2,955	4,874	2,024
Loire (Haute)	39,228	2,317	266	112	3,420	2,593	2,290	944
Loire-Inférieure	27,586	2,509	664	689	1,592	1,123	3,477	3,461
Loiret	17,459	3,958	326	191	1,418	807	3,300	1,885
Lot	40,855	4,684	2,200	1,412	7,380	6,910	7,139	6,898
Lot-et-Garonne	35,537	4,399	428	341	3,259	3,969	3,353	4,556
Lozère	15,977	1,404	255	180	3,180	1,509	5,160	2,306
Maine-et-Loire	13,866	1,312	500	300	7,342	5,024	3,499	2,412
Manche	32,428	2,390	435	358	3,930	2,270	9,517	8,269
Marne	19,460	4,853	404	155	2,501	1,231	3,386	2,218
Marne (Haute)	11,477	3,886	89	39	1,161	1,811	2,243	2,642
Mayenne	6,912	1,776	516	117	644	347	1,246	1,001
Meurthe-et-Moselle	19,287	2,472	158	80	1,928	937	3,818	2,615
Meuse	17,391	4,574	185	11	2,023	1,268	3,467	2,111
Morbihan	18,462	2,360	285	201	4,947	4,219	4,733	5,637
Nièvre	21,152	3,664	366	181	2,531	1,296	6,807	4,769
Nord	18,113	1,650	418	382	9,330	6,122	12,539	10,008
Oise	12,120	1,274	603	128	3,520	1,250	6,399	5,018
Orne	14,727	2,925	210	27	4,332	4,233	6,093	5,533
Pas-de-Calais	20,119	3,555	399	100	9,769	5,244	10,018	6,707
Puy-de-Dôme	74,877	6,156	1,753	306	11,445	12,078	8,977	8,505
Pyrénées (Basses)	31,095	3,937	396	109	4,495	4,048	2,916	2,528
Pyrénées (Hautes)	28,176	4,168	92	155	1,842	1,645	1,530	2,742
Pyrénées-Orientales	11,231	1,426	215	62	689	288	3,080	2,072
Rhin (Haut) [Belfort]	5,018	522	.....	.....	1,811	1,243	1,183	690
Rhône	25,411	1,419	647	465	2,691	1,924	3,376	1,837
Saône (Haute)	23,019	3,372	73	11	2,039	1,150	4,177	2,576
Saône-et-Loire	39,587	2,911	666	407	2,794	2,983	5,780	3,877
Sarthe	16,249	2,253	363	396	1,157	1,739	4,173	4,421
Savoie	44,022	8,036	1,098	1,111	1,374	1,239	1,155	916
Savoi (Haute)	48,693	5,455	62	50	2,565	1,582	1,515	1,551

engaged in agricultural work in Fance.

2.—Tenants, colonists, and metayers.								Total.	Total population.	Area in square miles.	Number of individuals per square mile.	Number of individuals engaged in agriculture per square mile.
Employers.		Clerks.		Laborers.		Day laborers.						
Men.	Women.	Men.	Women.	Men.	Women.	Men.	Women.					
8,422	1,669	408	371	1,309	955	1,552	1,154	69,300	365,462	2,254	162	31
4,744	60	484	167	4,526	2,174	6,473	5,266	72,932	560,427	2,995	180	24
19,194	1,337	671	466	2,461	1,179	4,148	2,093	64,459	405,783	2,821	144	22
4,246	435	20	1	579	632	127	803	34,077	136,166	2,685	50	13
974	143	.....	.....	18	7	130	16	27,753	119,094	2,157	54	12
5,372	235	1,235	108	5,080	1,360	2,350	1,825	20,762	203,604	1,511	134	13
8,244	107	138	126	4,717	2,266	2,525	2,527	82,370	384,378	2,134	180	38
1,528	179	60	21	401	133	993	739	31,935	326,782	2,020	161	15
5,500	214	191	196	958	627	612	688	51,046	244,795	1,989	123	25
1,600	191	72	11	322	188	1,152	1,321	32,302	255,217	2,317	110	14
4,421	828	668	918	1,099	1,158	543	502	81,998	300,065	2,440	123	33
3,020	302	25	3	1,688	1,360	1,876	1,553	74,699	413,826	3,370	152	22
9,068	806	283	160	1,046	303	4,501	1,383	48,931	556,379	1,970	287	25
13,215	1,817	550	394	3,650	2,249	9,557	7,985	80,224	450,220	2,133	211	37
3,838	134	592	400	1,011	974	2,879	1,139	53,283	231,086	2,206	104	24
11,995	1,034	155	84	725	228	1,024	500	68,663	373,950	2,294	163	30
7,452	1,546	500	20	827	870	684	854	85,635	465,628	3,635	129	23
5,508	203	150	100	3,000	1,165	2,296	1,000	81,636	345,613	2,780	125	29
7,743	197	100	50	2,500	1,500	3,000	2,000	67,944	311,525	2,287	136	30
3,265	185	29	.....	1,927	1,399	2,227	3,555	74,034	262,701	3,376	77	21
17,758	2,641	253	108	1,305	690	3,372	1,944	44,833	377,663	3,367	112	19
48,496	6,071	152	127	2,203	1,807	9,079	8,186	135,531	630,957	2,657	237	52
23,747	2,058	269	583	2,840	1,667	2,210	1,596	44,258	278,423	2,149	125	20
22,345	650	1,370	1,170	1,176	1,425	2,340	849	151,718	489,848	3,545	138	42
8,466	520	30	27	767	1,204	813	999	41,850	306,094	2,025	150	20
5,379	991	72	42	1,960	769	1,099	670	77,851	321,756	2,518	127	31
7,477	381	423	332	2,411	1,311	5,694	4,034	52,637	373,629	2,300	162	18
8,909	556	784	276	4,966	2,373	8,008	4,651	53,861	283,075	2,268	124	24
40,134	1,767	78	62	2,275	2,137	15,916	7,825	111,551	666,106	2,595	257	43
4,539	512	140	79	960	188	985	337	54,290	423,804	2,247	188	23
2,982	907	.....	.....	713	527	342	251	62,949	477,730	2,427	196	26
5,437	156	393	424	583	769	694	826	59,574	283,546	2,425	116	24
16,657	1,288	286	203	1,557	1,474	1,897	2,903	105,502	735,242	3,760	196	28
1,658	79	69	74	651	550	4,934	3,511	48,071	445,053	2,393	186	16
33,073	1,999	300	100	6,355	5,010	8,714	9,148	113,357	602,712	2,598	270	43
8,136	322	374	258	1,609	803	2,807	1,723	44,841	281,248	2,624	111	17
23,296	3,796	1,001	1,184	1,698	1,384	5,692	4,127	55,780	324,875	2,360	137	23
7,795	475	369	146	735	255	1,537	822	103,259	581,099	3,200	181	35
9,448	674	127	252	317	281	708	702	47,871	288,823	1,929	149	25
28,864	866	182	126	2,835	2,648	2,223	844	54,135	303,508	3,598	84	15
5,065	804	126	53	960	575	2,750	1,397	29,421	272,634	2,452	111	12
5,587	487	95	44	10,520	3,448	1,418	715	67,452	590,613	1,837	316	36
4,725	691	.....	7	2,235	1,192	1,305	1,661	62,986	313,721	1,915	164	32
28,326	1,194	753	813	1,507	1,270	3,689	2,309	80,962	612,972	2,653	231	30
6,473	1,379	345	204	2,724	958	3,037	1,435	45,899	360,903	2,614	138	17
1,517	189	100	.....	100	.....	536	320	80,140	276,512	2,012	137	40
11,328	1,154	124	115	2,095	1,965	1,348	1,036	85,007	316,920	2,067	153	41
2,882	665	65	23	88	69	639	826	35,228	138,319	1,996	69	18
31,989	2,409	100	.....	5,037	3,206	5,038	3,297	85,541	517,258	2,749	189	38
17,855	1,309	802	670	1,135	2,967	3,481	6,820	94,642	539,910	2,289	280	41
2,402	139	150	22	1,025	633	722	626	39,927	407,780	3,158	129	12
6,098	1,094	60	15	436	336	4,159	3,840	37,979	252,448	2,401	105	15
25,465	1,906	791	540	1,425	1,073	3,129	2,483	40,767	351,933	1,996	176	20
2,451	253	33	7	2,258	498	2,272	1,403	39,470	404,609	2,020	200	19
1,982	332	80	4	1,284	1,153	602	393	36,860	294,054	2,404	122	15
24,009	2,468	82	107	4,231	6,503	6,166	5,852	90,262	506,573	2,615	193	34
5,040	194	239	120	1,767	1,016	3,606	1,772	54,520	346,822	2,632	131	20
22,681	2,136	304	423	12,290	8,322	13,517	11,854	134,089	1,519,585	2,192	693	62
5,280	801	490	145	3,824	1,041	5,812	3,282	50,987	401,618	2,260	177	22
20,599	2,658	520	200	13,915	5,217	13,721	15,286	100,196	392,526	2,354	166	42
16,988	1,800	414	100	8,826	3,096	11,120	6,173	104,428	793,140	2,551	310	41
6,279	691	213	100	2,194	1,777	3,451	2,916	141,706	570,207	3,069	185	46
12,154	1,618	85	123	6,985	8,122	6,214	7,408	92,233	431,525	2,843	151	32
1,721	123	15	5	736	168	592	175	43,884	238,037	2,095	113	20
2,253	63	87	20	590	202	1,100	604	23,982	197,940	1,591	124	14
325	23	.....	.....	354	129	1,025	628	13,216	68,600	236	295	56
5,569	135	212	131	539	380	795	621	46,152	705,131	1,077	654	41
9,031	703	2	16	590	543	824	843	48,969	304,052	2,062	147	23
20,763	1,247	928	784	1,128	937	4,599	3,914	93,295	614,309	3,302	186	28
27,652	1,906	758	806	891	661	6,770	5,529	74,724	446,239	2,396	190	31
2,486	421	212	187	1,116	102	353	354	64,182	268,361	2,223	120	26
3,608	175	46	16	72	47	201	214	65,852	273,801	1,666	164	29

Detailed statistics of population engaged

Departments.	1.—Individuals cultivating their own lands.							
	Proprietors.		Clerks or employés.		Laborers.		Day laborers.	
	Men.	Women.	Men.	Women.	Men.	Women.	Men.	Women.
Seine	3,385	1,908	74	54	1,144	727	899	654
Seine-Inférieure	5,178	1,467	602	463	1,147	720	2,467	1,576
Seine-et-Marne	14,481	1,589	601	240	3,353	1,086	4,603	5,889
Seine-et-Oise	18,885	3,098	508	211	3,522	1,543	6,455	5,154
Sèvres (Deux)	21,154	2,613	538	343	1,852	808	3,954	2,777
Somme	13,860	1,121	461	162	6,713	4,534	8,977	7,095
Tarn	20,729	2,430	299	115	2,535	1,483	3,841	3,194
Tarn-et-Garonne	25,382	3,492	580	587	1,718	2,072	3,232	3,981
Var	17,486	2,315	179	189	2,686	3,881	6,298	6,824
Vaucluse	24,174	2,009	829	852	2,500	2,380	4,203	4,236
Vendée	16,023	3,025	260	222	1,599	1,728	3,448	9,807
Vienne	22,988	3,044	598	375	2,099	1,241	6,598	4,518
Vienne (Haute)	22,633	3,089	560	567	2,203	1,955	4,002	3,631
Vosges	28,687	4,415	176	49	2,580	1,728	7,309	5,661
Yonne	26,857	2,406	595	253	1,554	1,153	2,318	1,928
Total	2,078,517	248,740	42,926	26,518	276,818	187,456	442,572	348,592

in agricultural work in France—Continued.

2.—Tenants, colonists, and metayers.								Total.	Total population.	Area in square miles.	Number of individuals per square mile.	Number of individuals engaged in agriculture per square mile.
Employers.		Clerks.		Laborers.		Day laborers.						
Men.	Women.	Men.	Women.	Men.	Women.	Men.	Women.					
724	368	121	43	327	167	334	209	50, 138	2, 410, 849	185	13, 035	276
25, 914	1, 339	1, 796	784	2, 742	1, 472	6, 317	4, 158	58, 143	798, 414	2, 330	342	24
4, 663	556	940	276	3, 431	1, 346	5, 200	1, 978	50, 182	347, 323	2, 114	117	23
7, 103	1, 331	667	199	5, 206	2, 064	6, 830	3, 879	66, 651	561, 990	2, 664	209	25
14, 489	1, 987	882	668	2, 517	1, 018	3, 467	2, 322	61, 389	336, 655	2, 361	142	26
12, 490	1, 744	191	72	5, 765	3, 922	7, 905	5, 446	80, 666	556, 641	2, 535	211	31
11, 781	1, 796	124	72	2, 924	2, 455	5, 045	1, 843	60, 666	359, 232	2, 217	162	27
4, 907	834	127	144	343	401	1, 912	733	41, 445	221, 364	1, 436	154	28
5, 241	1, 034	90	63	918	1, 241	2, 564	3, 224	54, 130	295, 763	2, 328	271	23
7, 906	996	187	462	1, 445	1, 201	1, 238	833	55, 412	255, 703	1, 367	186	40
26, 642	2, 155	360	172	555	216	7, 108	5, 856	79, 186	411, 781	2, 588	160	30
13, 237	1, 085	241	216	857	903	2, 215	1, 825	62, 000	330, 916	2, 690	123	23
13, 828	1, 796	416	312	1, 384	1, 064	4, 003	1, 818	63, 271	336, 061	2, 129	154	29
5, 344	310	47	31	613	573	1, 019	946	59, 488	407, 082	2, 275	179	25
3, 452	133	256	110	714	399	1, 029	683	103, 850	359, 070	2, 868	125	36
952, 699	86, 964	27, 679	18, 593	198, 378	124, 047	297, 890	224, 590	5, 582, 970	36, 905, 788	204, 028	180	27

Notwithstanding the difficulty mentioned above, I have obtained, through the courteous assistance of Mr. Worthington, statistician of the department, data from which the following table has been constructed, showing the relations between the total population that is actively employed and that engaged in agricultural pursuits in the Northern and Western States, or that section of the United States in which there is any possibility of the culture of the sugar-beet taking firm hold and becoming a source of profit to the producer. From the figures given in these two tables, and the tables showing production in each department of France, each one may estimate for himself the possibilities of success in the introduction of beet culture for sugar production in his section as depending upon these relations:

Table showing total number and proportion of the inhabitants engaged in agricultural work, as compared with those engaged in industrial and professional occupations in the Northern and Western States.

States.	Total number engaged in agriculture.	Per cent. of employed population.	Per cent. of total population.	Number of farmers and planters.	Per cent. of population employed in agriculture.
Maine	82,011	39.4	13.1	56,941	69.4
New Hampshire	46,573	38.7	14.6	30,749	66.0
Vermont	57,983	53.3	17.5	34,144	58.8
Massachusetts	72,810	12.5	5.0	39,766	54.6
Rhode Island	11,780	13.3	5.4	5,954	50.5
Connecticut	43,653	22.5	8.1	23,704	54.3
New York	374,323	25.1	8.5	232,649	62.1
Pennsylvania	260,051	25.5	7.3	187,646	72.1
New Jersey	63,218	21.3	6.9	32,077	50.8
Delaware	15,973	39.6	12.8	7,642	47.8
Ohio	397,024	47.2	14.9	202,425	50.9
Michigan	187,211	46.3	15.8	121,558	64.9
Indiana	266,777	58.1	15.9	181,895	68.1
Illinois	376,441	50.7	14.8	240,256	63.8
Wisconsin	159,687	54.5	15.1	108,240	67.7
Minnesota	75,157	56.6	17.1	54,623	72.6
Iowa	210,263	61.1	17.6	139,478	66.3
Missouri	263,918	52.2	15.3	174,961	66.2
Nebraska	23,115	52.7	8.0	17,037	73.7
Nevada	2,070	7.7	4.9	1,242	60.0
Colorado	6,462	36.7	16.2	3,224	49.8
Dakota	2,522	42.8	17.8	3,208	87.5
Utah	10,428	48.4	12.0	7,044	67.5
Idaho	1,462	13.4	9.7	629	43.0
Montana	2,111	15.0	10.2	1,080	51.1
Wyoming	165	2.5	1.8	34	20.6
California	47,863	20.0	8.5	24,061	50.2
Oregon	13,248	43.2	14.5	9,758	73.6
Washington	3,771	38.6	15.7	2,880	76.3

Table showing total number and proportion of the inhabitants engaged in agricultural work, as compared with those engaged in industrial and professional occupations in the Northern and Western States—Continued.

States.	Number of farm laborers.	Per cent. of population employed in agriculture.	Number in all occupations.	Per cent. of the population.	Area in square miles.
Maine	24,738	30.1	208,225	33.2	31,766
New Hampshire	15,666	33.6	120,168	37.7	9,280
Vermont	23,692	40.8	108,763	32.9	10,212
Massachusetts	31,019	42.6	579,844	39.7	7,800
Rhode Island	5,475	46.4	88,574	40.0	1,306
Connecticut	18,934	43.3	193,421	35.9	4,674
New York	134,562	35.9	1,491,018	34.0	47,000
Pennsylvania	68,897	26.4	1,020,544	28.9	46,000
New Jersey	29,240	46.3	296,036	32.6	8,320
Delaware	8,131	50.9	40,313	32.2	2,120
Ohio	191,063	48.1	840,889	31.5	39,964
Michigan	64,885	34.6	404,164	34.0	56,243
Indiana	83,949	31.4	459,369	27.3	33,809
Illinois	133,649	35.5	742,015	29.2	55,405
Wisconsin	50,753	31.7	292,808	27.7	53,924
Minnesota	20,277	26.9	132,657	30.1	83,500
Iowa	69,821	33.2	344,276	28.8	55,045
Missouri	86,807	32.8	505,556	29.3	67,380
Nebraska	5,899	25.5	43,837	35.6	122,007
Nevada	555	26.8	26,911	63.3	83,500
Colorado	2,659	41.1	17,583	44.1	106,475
Dakota	308	12.2	5,887	41.5	318,128
Utah	3,048	29.2	21,517	24.8	109,600
Idaho	720	49.2	10,879	72.5	.....
Montana	670	31.7	14,048	68.2	.....
Wyoming	58	35.1	6,645	72.9	.....
California	16,231	33.9	238,648	42.6	159,000
Oregon	3,126	28.5	30,651	33.7	100,000
Washington	742	19.6	9,760	40.7	53,924

The relations between the proprietors or tenants of farms and laborers in the beet growing sections of France are comparatively simple. In many cases the family of the land-holder joins him in the labor required in the production, but in the great majority of cases he must secure assistance from external sources. Sometimes laborers, men and women, for hoeing, weeding, and pulling the crop, are employed by the land-holder himself, and he performs the function of overseeing the work in the fields, and this is the method generally pursued in sections in which day laborers are easily obtained, but in sections in which labor is scarce the contract system is resorted to, and the work of cultivation is intrusted to a single person at a given rate per acre, and this individual undertakes to find the laborers and do what is required. The rate of pay for agricultural work varies from 50 to 90 cents per day for full-bodied and adult laborers, being less for some women and children that may be employed.

But the relations between the producers and the manufacturers are much more complicated in their character, and often give rise to serious

difficulties and vexatious disputes. Under the plan of sale and purchase of the crops at a given rate per ton, as fixed in the contract between them, it becomes the desire of the producer to obtain from the land planted in this crop the largest possible quantity, without regard to quality. On the other hand, the manufacturer, studying his own interests alone, and desirous to obtain the largest possible profit from the material he must handle, would have only good quality, without regard to the quantity that may be yielded per acre to his colleague, the producer. In the pages which precede this we learn that large yields per acre generally meant, in the ancient modes of culture, large roots, and these large roots were found to contain much larger quantities of organic and mineral matters other than sugar than roots of smaller size, and that these impurities have deleterious effects upon the quantity of sugar that may be extracted by the means usually employed in the factory. We have also seen that there are various influences tending to the increase of the impurities, among which we have mentioned qualities of soil, depth of plowing, character of the fertilizers employed, and the time and mode of applying them, the kind of seed used and mode of planting it, and the treatment of the crop during growth or subsequent to harvesting it; and all these matters the manufacturer seeks to control, making them so far as possible the basis of the conditions of the contract, to which the farmer on his part must submit. He also endeavors to secure to himself the right to superintend, personally or by proxy, the work of preparing the soil, application of manures, and sowing, and to furnish at the lowest market rates the seed to be sown; the latter to be paid for by deduction from amount due the grower on delivery of his crop to the factory. But, as before stated, the existence of all these conditions produced innumerable disputes, involving many costly suits at law, and intelligent agriculturists and honorable manufacturers have endeavored to determine a means by which both the farmer and the manufacturer may be free from all special conditions in the production of the crop or its acceptance for manufacture, and this has given rise to the system of purchase by density, or according to the quality of the product delivered at the mill. In the study of the means of estimating quickly and accurately the quantity of sugar existing in the juice of the beet root, it was found that if the density of a sample of the juice of a root be taken shortly after being pulled, there is a definite relation between this density and the proportion of sugar it contains; and it is this relation that constitutes the basis of the new system. They retain so much of the old system as provides for the determination of the amount of tare to be allowed when the roots are delivered, however, and this is effected in the following manner: The director or superintendent of the works being present at the time of delivery, acts in concert with another person who is employed to act on behalf of the producer. Each select from one or more loads three or more beets, such as it is understood he considers a fair average of those constituting the

load. In actual practice the representative of the farmers selects the best specimens he can find, and the superintendent of the factory takes the worst specimens obtainable.

The roots thus selected are then weighed, the adhering dirt and the useless portion of the tops and leaves that may remain removed, and the difference in weight found by a second weighing is accepted as a basis for calculation of the tare to be applied to the entire crop to be delivered. The manufacturer has, however, always the right to demand a new determination of the tare, if at any time during the delivery of the roots he considers them in worse condition than at the time of the first determination.

After the same manner the quality in the new system is determined.

In the first place, the rate to be paid according to the density of the juice is fixed in the contract between the supplying and receiving parties, and this is generally $4 per ton of 2,200 pounds of beets, the juice of which has a density of 1.055. The scale of the densimeter used in the estimation of values is so divided that the figures representing what are technically called degrees of richness may correspond with the hundredths figures representing the specific gravity. Thus, 5 degrees in the scale of richness means a density of the juice equal to 1.050, and 5.5 to 1.055. A beet giving a juice having a density of 1.055 is considered of good average quality, and will contain about 11.2 per cent. of sugar, and this root will yield in manufacture about 6 per cent. of merchantable sugar. It would be better, or, rather, more nearly correct in this work, to make at the same time an estimation of the organic and mineral impurities; but this would require special knowledge not possessed by the farmer, and the value, as determined, would be by no means as manifest to him, nor would it be as readily accepted by him. By the method proposed in the use of the densimeter, he is able to participate in the estimation of the quality, and he can much more readily understand it.

A juice having a density of 1.055, or of 5.5 degrees, is considered of very fair quality, and this degree has been adopted by many as that upon which the price of $4 per ton of 2,200 pounds shall be based. The variations of price for degrees above and below this standard degree of richness is determined and settled upon in each contract; but it is in general, where the system has been adopted, 4 francs (80 cents) for each degree; that is, for each degree above the standard, 5.5, this amount is added, and for each degree below the standard the same amount is deducted. But this standard of values, depending upon the degrees of density above and below 5.5, has been the subject of earnest discussion, for it has been found that the same relation between the density of the juice and its sugar content does not always hold good for degrees above and below the figure adopted.

The commission established to determine the readiest means of estimating the value of the root for commercial purposes acknowledged this fact, and that while the reading of the instrument might correspond to

2 per cent. of sugar for each tenth between 5.0 and 5.5, above and below these limits this coefficient is incorrect. Below the lower limit the beets are less rich than is indicated by the densimeter, and above the higher limit they are richer than the indications. By the same commission it was questioned whether there should be established a relation between the price of sugar in the markets and the standard price to be paid for roots having a richness corresponding to 5.5 degrees of the densimeter, but they concluded, after a consideration of the matter, that this would be impracticable.* But M. Blondel proposes a scale of prices to vary with the ranging prices of sugar in the market, and, accepting 4.5 degrees as the standard, believes it just to make a standard price for this degree, and an addition of 3 per cent. for each tenth of a degree above, and a similar deduction for each tenth of a degree below. When sugars are worth 14 francs ($2.80) per 100 kilograms (220 pounds) in the market, he would pay 14 francs per ton for roots the juice of which has a density of 4.5 degrees, and for each increase of one franc in the market prices of sugar he would add 25 centimes (5 cents) to the standard price per ton of roots. The system of purchase by density, while it ameliorates the relation between the manufacturer and producer, places a check on the grower of roots of bad quality, and furnishes a premium to the producer of those of good quality, and becomes an incentive to effort in the further improvement of the saccharine value of the crop.

The actual relations between the manufacturers and farmers in France, under the old and new systems, are well illustrated in the following copies of the old form of contracts and of the record of proceedings of the *Reunion of Agriculturists*, held at St. Quentin, March 25, 1876, for the determination of a new form of contract, which they finally adopted, and which I have been able to obtain through the courteous intervention of Mons. H. Vilmorin, of Paris.

Copy of table of conditions in use at Saint Quentin.

THE AISNE SUGAR MANUFACTURERS' CLUB.

SUGAR-BEETS.

The designation *sugar-beet* excludes the varieties known as Disette, *corne de boeuf*, long, yellow globe, and *bettraves bouteuses*,† or those grown upon cleared forests or marshes.

Beets when delivered shall be cut off immediately below the last or lower leaflets. They shall be healthy and free from all alteration.

Tare.—Tare comprises, besides earth, the rudiments of leaves and woody portions of the top.

Reception of beets shall take place at the factory, or, if *possible*, at the boat-landing.

Journal des Fabricants de Sucre, 1878, March 6.

†According to a decision by arbitration of January 5, 1872, and confirmed by decree of the court of Douai of July 3 following, beets of the variety *bouteuse* or *Boutoire* are not merchandise of good grade, and may be refused by the manufacturer.

SUGAR FACTORY OF THE SOCIETY OF PERRUWELZ, AT PERRUWELZ.

No. 71.

Between the subscribers: of the first part, the administration of the Society of Perruwelz for the manufacture of sugar from beets and of animal charcoal, the headquarters of which is at the establishment of Perruwelz; of the second part, M. Louis Leturcq, cultivator, domiciled at Roucourt. Parties to the following agreement:

ARTICLE I. The party of the second part engages to cultivate during the campaign of 1874, in beets called Silesian, green top or pink top, the following quantity of land:

ART. II. The grower may use only the seed furnished by the factory or permitted by the administration, and in the latter case at his own risk and peril.

ART. III. The seed shall be furnished by the factory from the 15th to the 31st of March at the price of 1 franc per kilogram (9 cents per pound).

ART. IV. The beets shall be planted before the 15th of May upon a good clay or sandy soil, suitably prepared without excess of manure. The latter shall not be distributed after June 15, neither shall direct application to the plant be allowed.

ART. V. The plants shall remain completely provided with their leaves—that is, the leaves may not be cut off for feeding purposes until the time for pulling, which shall not be made more than five days before their delivery at the factory. However, after the 25th of October the beets may be pulled at once and piled in heaps or stored in trenches until the time of delivery.

ART. VI. All beets shall be delivered healthy, free from earth, leaves, and "*turols.*" Their weight shall be determined at the office of the scales at Perruwelz, with a tare of 5 per cent. This tare shall be rated according to the cleanliness and the quality of the beet. Above 15 per cent., and if the beets are rotten, frozen, or of bad quality, the purchasers may refuse them, or accept them with a tare, which they alone shall value or appraise.

ART. VII. The delivery of the crop shall be made at the trenches of the storehouse of the sugar-works of Perruwelz at the price of 20 francs ($4) per 1,000 kilograms (2,200 pounds).

ART. VIII. Beets grown in gardens or upon low, wet, or turfy soils will be refused.

ART. IX. The purchasers reserve the right of inspection by their employés of the fields planted, in order to be assured that there is no detraction from the agreements herein stipulated; and in case of infringements it shall be optional with them to make a reduction of 2 francs (40 cents) per 1,000 kilograms (2,200 pounds) or to declare the present contract null and void.

ART. X. The person furnishing the roots shall have the right to a quantity of pulp equal to 20 per cent. the weight of the roots delivered by him, at an average price of 10 francs ($2) per 1,000 kilograms (2,200), but he shall lose this right if he fails to come and take the delivery on the day which shall be indicated by the manager of the society.

ART. XI. In order to avoid obstruction on the reception of the crop, the dates for the deliveries shall be at suitable times designated by the purchasing administration, having regard for the greater or less quantities of the crops to be furnished, and in general in such a manner that 15 per cent. and no more may be called from the 15th to the 30th of September and 50 per cent. from the 1st to the 25th of November and not after.

ART. XII. Payment for roots furnished shall be made as promptly as possible, but certainly before the end of January.

ART. XIII. Beets pulled with a hook shall be refused.

LOUIS LETURCQ.

(Made in duplicate at Perruwelz this 8th day of January, 1874.)

The following is a copy of the record of the proceedings of the *Reunion of Agriculturists* held at St. Quentin (Aisne), France, March 25, 1876, for the consideration and adoption of a form of arbitration bond between growers of beets and sugar manufacturers, depending upon the new system of purchase of beets by density of the juice:

Arbitration bond adopted by the Reunion of Agriculturists held at Saint Quentin (Aisne), France, March 25, 1876.

The reunion of agriculturists of the arrondissement, called together for the purpose of studying the means of fixing upon a better defined basis of the relations between the sugar culture and industry, and to examine in its practical relations the purchase of the beet according to its quality, met on the 25th of March at Ferragues in the hall of the *Tribunal de Commerce.*

Two hundred and forty cultivators assisted at this reunion, under the presidence of M. Albin Damoisy.

In opening the meeting the president called attention to the promptness with which the growers responded to the call of the committee. They thus prove that they comprehend the joint responsibility existing among their members and that they are capable of uniting when their interests are at stake.

The president then stated the motives which induced certain agriculturists to call this reunion together.

The crisis bearing upon sugar manufacture enters into the culture of the beet in a new phase. The manufacturer now demands a richer raw material than in the past, the purchase of which shall be based upon its quality.

The cultivator does not object to this reform, but wants it in such a way that his interests may be guarded.

The quality of the sugar-plant may be thus stated: The density of the juice is a certain index of the saccharine richness. Science and practice are in accord on this point. On the other hand, the means for taking the density have been the object of serious study, and in this relation also practice has shown that certain methods offer for the seller, as for the buyer, the double guaranty of impartiality and exactness.

But it is not enough to possess practical means for determining the quality. It is further necessary to be able to determine a price according to these variations. For this purpose a basis must be fixed. Culture admits of 5 degrees because this figure corresponds with the average density of our region, and indicates a plant of good quality, susceptible of yielding a profit to the industry which transforms it.

On the other hand, if the cultivator consents to reductions of price below the basis, he requires that all superior richness shall be paid for proportionally, a requirement conformable with good sense and equity.

As to the refusal of merchandise which does not possess a minimum richness, this is an inadmissible requirement. The producer of beets cannot involve his interests in a situation which leaves him such uncertainty, because the quality of the plant does not depend simply upon his operations, but upon atmospheric circumstances as well. Besides, the purchase according to quality, which gives the manufacturer the right to reduce the price when this quality is below that of the base, assures to the sugar-works sufficient guaranties.

The *Société des Agriculteurs de France* has thus decided, because by a majority of 116 votes against 42, it rejected this idea of limitation.

In short, the plan of arbitration bond proposes an arbitration to settle possible conflicts. The beet is an encumbering merchandise, and subject to rapid alteration. It cannot, like the cereals or oleaginous seeds, be stored. It requires that all differences relative to the delivery shall receive prompt solution.

Growers have therefore no cause to be timid concerning the new mode of purchase proposed, provided the practice be regulated in a judicious manner in advance.

This innovation would involve the necessity on the part of the producers of beets of placing at each factory a representative charged with the inspection of the manifold operations connected with their deliveries, and the sugar works would willingly accept this agent, not only because it would be the exercise of a right, but also because this agent would relieve them of all responsibility to the vendor.

En résumé, the plan of an arbitration bond submitted to the assembly is intended to prevent the return of the difficulties of 1875. It takes account of the reclamations raised by the sugar manufacturers, and at the same time guards the interests of the growers.

A work of conciliation, this arbitration is not drawn up for the exclusive profit of one of the parties; growers and the sugar manufacturers alike may make it the basis of their conditions.

After this statement followed by a discussion participated in by Messrs. Lalaux, Lehoult, Ernest Robert, Thuete, Eustache Damoisy, Suin, Francois Honorez. Gladieux, Gonzelle, Voiret, and other cultivators, the different articles of the plan for the arbitration bond were successively studied, modified or adopted, and the assembly adjourned, after having adopted almost with unanimity the entire arbitration bond worded as follows:

ARBITRATION BOND BASED UPON PURCHASE ACCORDING TO QUALITY.

ARTICLE I. The beets shall be delivered at the sugar-factory, the rasping-works, or the scales.

ART. II. They shall be delivered healthy, without top, cut off immediately below the last leaves.

ART. III. "*Bouteuses*," or forage beets, frozen or altered ones, or those coming from marshes or cleared woodland, shall be refused, or at least specially reserved.

ART. IV. The delivery shall be made on all workable days, without interruption, from five o'clock in the morning to seven o'clock in the evening in September and until the 15th of October. After this date it may take place from six o'clock in the morning until six o'clock in the evening.

ART. V. The discharge of merchandise must be cared for by the purchaser, who shall take measures necessary to prevent delay in transportation.

ART. VI. The weight, tare, density, and all operations depending upon the delivery shall be taken in presence of the vendor or his agent and assistants.

ART. VII. The tare shall be determined with a basket of beets taken without choice, and in the same manner as the discharge is effected.

ART. VIII. The density is taken with the same lot of beets which have served for determination of the tare. It is taken with each tare and immediately after it.

ART. IX. The density shall be taken by one of the three methods given below:

1st. Either by rasping the entire basket of beets that have served for taking the tare.

2d. Or by dividing all the roots in the basket into fourths, in the direction of their length, and rasping one-fourth of the whole.

3d. Or using the cylindrical borer, which shall be passed into each root in the basket in a transverse direction near its center of gravity—that is, at about the upper third of its length—after it has been topped.

ART. X. The density shall be taken and expressed in figures only after ten minutes after the densimeter (*pese-jus*) shall have been immersed in the liquid.

ART. XI. The manufacturer of sugar shall not use the numerous operations dependent upon taking the density as a pretext for delay in the entry of beets to his works.

ART. XII. The price is fixed at —— francs per 1,000 kilograms (ton) for beets, of which the pure juice at a temperature of 15° centigrade (62° Fahr.) shall mark 5° on the densimeter.

ART. XIII. All degrees of density are paid for, and the price applied to the basis

shall be increased or diminished according to the ascending or descending variations of density.

ART. XIV. The additions to and reduction of the value are estimated thus:

1st. Each tenth of a degree above the basis gains a premium of 2 per cent. between 5° and 6°, inclusively, and of 3 per cent. above 6°.

2d. Each tenth of a degree below the basis shall effect a reduction of 2 per cent. between 5° and 4°, inclusively, and 3 per cent. below 4°.

3d. These 2 per cents and 3 per cents are calculated upon the purchase price applied to the basis.

ART. XV. The person furnishing the beets shall have a right to a quantity of pulp corresponding to 20 per cent. the total weight of his deliveries. The price of these pulps shall be —— francs per 1,000 kilograms (ton). Everything is reserved concerning pulps obtained from continuous presses.

ART. XVI. Payments shall be made according to the following conditions:

* * * * * * *

ART. XVII. All differences on the subject of the present market, or operations depending upon it, shall be judged with little delay and as a last resort by arbitrators chosen by the parties, and whose decisions they agree to accept. In case of failure of agreement by these, then, by a third arbitrator named, at the request of the complainant, by the president of the "*Tribune de Commerce de St. Quentin.*"

St. Quentin, March 25, 1876.

ERNEST ROBERT, *Secretary.*

ALBIN DAMOISY, *President.*
LALAUX,
CARLIER JULES,
THUET,
BELMER,
BOURY,
PAUL DELACOURT,
OBLET-MILLOT,
VIRGILE DAVIENNE,
Agriculturists.

It is considered by the later authorities who have given attention to the relations between the producers of beets and the manufacturers of sugar, that it is of great advantage, and is a potent means for reducing the chances of conflict between these two branches of the industry under consideration to have the farmers part owners in the factory. That is, in securing capital for establishing a factory in any section for the extraction of sugar from the beet, the farmers who must supply the raw material should be induced to subscribe for a certain amount of stock, and have in consequence a voice in the management, thus securing a bond of mutual interest. This is the plan that has been followed with good results in Germany, where the number of shares that may be held by the farmer is based upon the area of surface he may engage to cultivate in beets for supply to the factory.

The engagement by those having no ready money to cultivate a certain area for supply to the factory is also sometimes accepted as an offset to the capital of those having no landed property. While such conditions would scarcely be entertained in this country there would appear to be no doubt of the importance of the influence that such a system of copartnership between the manufacturer and the farmer would exert in the introduction of this industry so novel to our people.

CHAPTER VII.

MANUFACTURE—PROCESSES AND ECONOMIES.

The rapid decrease in the values of sugar has rendered necessary the strictest economy in all the modes and apparatus employed in separating it, and every possible means that has been devised for reducing the cost of securing the sugar is being adopted.

This is evident in the relations between the producer and manufacturer that have already been discussed. But in the work directly under the control of the manufacturer there are three sections which have claimed the attention of progressive men, and in which the greatest economy and improvement have been attained. These are methods for reducing the cost of transportation of the raw product to the mill, and securing a larger quantity to be worked at each establishment; for securing from the roots a larger quantity of juice at a reduced cost for labor and machinery; and for saving the sugar lost in the molasses, which has heretofore been utilized in the distillery to the loss of the sugar manufacturer.

In the first of the methods for reducing the general cost of sugar production we have the system devised by Linard for the subterranean transport of juice through pipe lines, by which it is possible to establish small works for the extraction of the juice in sections in which it would be impossible to secure supplies for a factory of capacity sufficient to insure economical and profitable working, and to provide a cheap and ready way of sending the juice extracted to a central factory of large capacity and with the consequent appliances for separating the sugar at a minimum cost, and at the same time leave the pulp in the immediate neighborhood of the producer, who finds in this waste product a source of profit in its well-known value as cattle food. Maumené has given, in his *Traité de la Fabrication du Sucre*, page 207, &c., a description of the system which is so complete that we consider it of value to give a translation of it here. His description is as follows:

To the extraction of the juice is attached a new method we are about to describe, that of the subterranean transport of the juice. This is not a special means for extracting the juice but simply a means of procuring beets from very great distances without an excess of the cost confined within the prescribed limits. The juice never representing more than 80 per cent. of the beet, its transportation would comprise at most four-fifths of the ordinary cost; besides, the flow of the juice in a tube may take place with no cost except the expense of purchase and placing of the pipe, when there is sufficient fall between the rasping-works and the factory. But without such very rare conditions only a pump and a little steam-power will be needed to overcome the resistance in the tubes themselves or counter inclinations. In fact, this mode of transport offers a more or less decided economy upon the ordinary method, and it has the especially enormous advantage of being always practicable when ordinary transportation may be arrested in default of horses, drivers, or even by bad roads. Besides, the profit resulting from the non-transportation of the pulp is doubled by a possibly greater benefit, that of delivering the pulp to the grower in the best condition at the same place to which he brings his beets, and in a covered place, with no intermediate charging or discharging, as occurs in the usual system, especially on the

scales from which they are almost always thrown upon the ground, even in a rainy time.

Since 1867, the year of the establishment of the first pipes at Mont Cornet (Aisne) for the length of more than 8 kilometers,* rasping works have been constructed in increasing numbers and at greater distances. There are now in existence (May 1, 1875) 240. One of them serves a factory 32 kilometers distant, and the system has everywhere given good results.

The juice cannot be poured into the pipes in the natural condition; certain preserving agents must be provided, and under all conditions there is nothing comparable to lime. I may be permitted to say that without my studies on the preservation of the juice and the industrial tests of my process founded upon this preservation, Linard could not have thought of transporting so alterable a liquid in pipes of such length. With lime there is no fear of alteration, and the juice may travel long distances.

"Experiments made in the laboratory and industrially have sufficiently demonstrated that by the process of the Chemist Maumené juices may be preserved several months, and even several years, and the case in point is but a modified application of this process. The juices therefore preserve all their qualities during their passage through the conduit." Such is the appreciation of Mauré, the colleague of Linard, in his note of 1869.

The juice is limed at the rasping-works with one per cent. of lime, Ca O; the solution is total and rapid. After repose of twenty-four hours or less the limpid juice is taken by a pump and forced into the pipe, which should be buried to a depth sufficient to be protected from frost (24 to 30 inches). This pipe, which should be of iron of the first fusion, has a diameter which varies between 2½ and 5 inches, according to the quantity of juice to be delivered, the length of the course, and the accidents of the land. All precautions should be taken to secure a good construction of the pipe, mechanical molding, upright casting, in order to have good close iron, free from bubbles, and of a regular thickness; and testing of all tubes at 15 atmospheres before delivery, &c. These tubes are 3.3 yards long. They are joined by a socket with a tarred cord, upon which lead is poured; the metal is finally tamped with a mallet. The pipe being finished, it is filled with water before being covered. The few joints at which leaks occur are retamped and the pipe covered. In case of subsequent accident, all loss of juice promptly becomes evident at the surface of the soil. The pipe is generally laid on the roadside, where the "*cantonnier*" or a special employé may easily see the slightest leak and report it to the factory. A loss of eight or ten quarts cannot be avoided, but it represents at most only 5 or 6 cents.

The highest points of the conduit are provided with stopcocks to remove the air and avoid (*coups-de-belier*) shocks. These shocks are never very severe, the rapidity of flow of the juice never being more than 1 to 1½ inch per second; whenever they may probably be produced, all possible care should be taken to avoid them. One of the most unfortunate cases is the sudden obstruction of the pipe in full operation; this obstruction may be brought about by insoluble deposits of lime mixed with coarse pulp, pieces not reduced by the rasp, &c. The surest means of obviating such accidents consists in never pumping turbid juices into the pipe, which may be readily effected by allowing twenty-four hours of repose, as I have said before. Many persons object to this means, because it leaves a calcareous deposit, which must be washed, and send the juice simply filtered through chopped straw, then passed through a metallic screen, or even simply passed through the screen before delivering it to the pump. It is more simple to wash the deposits in a small automatic washer, and to employ the waters to hold the lime for the juices coming from the presses.

Felix has invented a good mode of purging the pipes of the air which the juices contain, the accumulation of which is very deleterious to the good progress of the work. An iron bell, tested at 15 atmospheres, like the pipe, is placed at an elevated point on the pipe in an opening, where it is adjusted by two opposite tubulures sol-

* 1 kilometer = 0.6214 miles.

dered to its lower part. In the center is a pump cylinder in which slides a piston, the rod of which passes through the summit of the bell and communicates motion to a safety-valve. The air rises to the summit of this purger about the pump-cylinder, and gradually exercises a sufficiently strong pressure upon the piston to cause it to descend and open the escape-valve. A large portion of the air is thrown out, the piston rises, closes the valve, and so on.

It is indispensable to verify the condition of the juice on its arrival at the factory. A small $\frac{3}{8}$-inch iron tube, with a stopcock, should be arranged to deliver *ab libitum* 500 to 600 cubic centimeters in which to determine the proportion of lime added. Heretofore lime has not been used in a sufficiently exact manner. A large vat of juice badly limed may occasion serious trouble in the work. Let us admit a vat of 400 hectoliters (8,800 gallons). Such a volume of juice introduced to a conduit of 10 centimeters (3.9 inches) diameter would occupy a length of 5,000 meters (5,458 yards), *i. e.*, it would fill the entire pipe of certain rasping-works. It is thus possible, on the one hand, to cover the entire interior surface with a viscous stratum, which in fermenting would considerably reduce the quality of the juice to follow, even supposing a somewhat better liming, and, on the other hand, arriving at the factory its mixture with the other juices render the work difficult and often bad for several hours. It is of the utmost importance to watch this danger.

Rasping-works seem to be a source or great expense, but this is certainly a delusion. One may be convinced of this by carefully examining the conditions of their operation. They may involve no surplus of expense, and simply be a source of profit when placed in such a way as to *increase the capacity of the factory, without taking away any part of it.* The rasping-works furnish the factory with supplies of beets that would otherwise be inaccessible, and in quantity sufficiently large as not to increase the net cost of the juice. This end is easily arrived at by the numerous advantages of the rasping-works, of which we shall present a succinct *résumé.*

One of the greatest of these advantages is to obviate the possibility of arrivals of beets above a certain limit on the same day. Thus the arrival of 200 tons would require an average of 50 to 100 carts. But in the first days, when each one is hurried, or when it is necessary to secure supplies, 4, 5, 6, 20 times this number may arrive, and it is easy to understand that their reception would be impossible. Subterranean transport removes these difficulties; it is possible to receive enormous volumes of juice with no other inconvenience than to provide the necessary recipients.

In transportation by means of wagons the roads are subject to such degradations that the administration causes the manufacturer to pay, under the title of *manufacturing grants* (*subventions industrielles*), for all the injury caused on account of beets, with no distinction between the manufacturer and the grower, so that the grower, whose beets are not received by the factory by default of quality, has left him the right to carry them home at the cost of the manufacturer. One factory has paid 32,000 francs (about $6,400) in a single year. Manufacturing grants are suppressed by the rasping-works and pipe-lines. All that remains is the insignificant cost of the care of the ground in which the conduit is buried, and in place of a sort of antagonism between the manufacturer and the administration, there is complete harmony by reason of the convergence of otherwise opposing interests. Another serious advantage is the non-concentration of the entire *personnel* in the factory. Division of labor is always of highest interest. Rasping and pressing, especially with hydraulic presses, employ the most numerous portion of the workmen. The requirements of the rasping-works alone are therefore often beyond the possibilities of the local population. Added to this is another and stronger reason, that several rasping-works of the same power is an absolute impossibility in the factory. It is an easy thing to leave the laborers at home, where they may remain, by putting the rasping-works in the distant villages.

The farmers of certain localities may not be able to grow beets on account of their special situation. Removed, not by real distance, but by too pronounced accidents

of the land, it is impossible for them to devote themselves to a culture the products of which are not transportable. Local rasping-works resolve the difficulty. Its pipes may be conformed to the most variable lands, and carry to the factory all the juice of the roots, leaving the pulps on the place for the cultivator. It will probably be easy in the near future to sell the juice by the saccharimetric degree, and not according to the weight of the beets. This is really a problem of common interest to the grower and to the manufacturer.

The conduit is used about four months. During the remainder of the year it may serve for transportation of water. This office has in earlier times contributed to the success of a factory, the supplies for which could not possibly be increased without this means of transport. Growers, located upon a plateau too dry for the purpose, engaged to grow beets in return for an engagement to furnish them water by the conduit.

These numerous advantages are by no means annulled by the expenses; this is very evident. Rasp and presses were necessities of the works. Even the boilers are not an increase; a factory does not operate with a single boiler; there are several, and the number increases according to the needs. Even the buildings are not an extra expense. These would have to be increased in the factory. The conduit is really the only new expense for stock. Adding two or three individuals to the *personnel* and a force-pump, and the account is complete.

A conduit of 10 centimeters diameter (3.9 inches) costs 7,000 to 8,000 francs ($1,400 to $1,600) per kilometer (0.62 miles); let us suppose 28 or 30 (18.60 miles) kilometers; 30 kilometers, for instance, it would cost 240,000 francs ($48,000) or 24,000 francs ($4,800) per year interest and redemption. It is possible to carry in 120 days 120 times 2,500 hectoliters (65,000 gallons), or 300,000 hectoliters (7,800,000 gallons); *i. e.*, the juice of 37,500 tons of beets, at least. Now it is usual to obtain the beets at 2 and even 3 francs (40 to 60 cents) less per ton at the rasping-works. There is therefore a gain of 75,000 to 122,500 francs ($15,000 to $22,500), which largely compensates for the 24,000 francs ($4,800) of interest, the slight increase in the *personnel*, &c., at the great distance spoken of.*

The force-pump necessary to overcome the resistance in the conduit requires an average of 1 to 8 or 9 horse powers; say, 5. Each horse-power costing 2 francs (40 cents) per day, the expense for 120 days will not exceed 1,200 francs ($240).

The ground is sometimes an extra cost; 1 hectare (2.47 acres) never costs more than 6,000 to 10,000 francs ($1,200 to $2,000); even at the latter price the annual interest is 500 francs ($100).

There are at present in France 145 of these rasping-works supplying central factories. Of the latter, that at Cambrai is considered one of the most important, and is described by a writer in the *Journal des Fabricants de Sucre* in the following terms:

It was started in 1872, after those of Origny, Sainte Bernard, and Meaux, which marked the beginning of this well-known system of causing to converge at a single point the juice extracted in several rasping-works. The rasping-works placed in purely agricultural centers have no other function than to extract the juice and send it, by means of subterranean pipes, to the central works, situated near to a canal or railroad, where may be found the apparatus necessary for the conversion of this juice into sugar. The principle of the division of labor upon which this system rests has found in the works at Cambrai one of its most extended applications; and we believe that nowhere have they succeeded in reducing in a greater proportion the cost of manufacture. It is particularly here that the system of M. Linard, the inventor, should be seen; and it may be said that it is especially at Cambrai that the concen-

* Maumené's figures may be somewhat simplified, as follows: At the rates for cost he assumes the figures would be $2,250 to $2,500 per mile—suppose 20 miles. The cost would be $50,000 and interest and redemption $5,000 per year. The amount of juice that could be transported and the saving on inferior prices of beets would be the same.

tration of work and the reduction of the general costs and the costs of manufacture have given the most significant results. Compared with other works, this reduction of costs has been from 80 cents to $1 per ton of beets; and we speak only of works well supplied with apparatus and well directed, working 15 to 20 thousand tons per annum without annexed rasping-works. * * *

In 1872–'73, the first year of working the factory, with 14 rasping-works, and handling upwards of 64,000 tons of beets, the total expenses were 12.27 francs ($2.45) per ton. In 1876–'77 these expenses, with 90,000 tons of beets, were 12.11 francs ($2.42). In 1877–'78, with 18 rasping-works and handling 112,000 tons, they fell to 10.02 francs ($2); or 11.02 francs ($2.20), if we add the storage of beets, not included in the figures just given. No ordinary works, however well they may be supplied with apparatus, can work within these limits of cost; and we see that M. Linard was right when he said it was possible to realize with his system at Cambrai a saving of 4 to 5 francs (80 cents to $1).

At their creation the Cambrai works comprised 14 rasping-works, and the total length of the subterranean pipes was 59 miles. To-day, 1879, they employ in winter 1,200 laborers, and are supplied from 18 rasping-works, which pour the juice through 77.5 miles of subterranean pipes.

The following table will serve to show the condition of the works at Cambrai, and the results obtained for a series of years:

Condition of central factory at Cambrai, and results obtained in a series of years from 1872 to 1879.

Years.	Number of rasping-works.	Length of subterranean pipes, in miles.	Number of acres sown in beets.	Total quantity worked, in thousands of tons.	Quantity of pulp, in thousands of tons.	Sugar obtained in sacks of 220 pounds each.	Residue of molasses, in thousands of tons.	Residue of scum, in thousands of tons.	Total cost of manufacture per ton of beets.
1872–'73	14	58.90	748.98	64	12.8	32,000	2.3	5.5	$2.454
1873–'74	17	70.37	1,214.57	111	23.3	61,605	4.3	10.5	2.626
1874–'75	17	70.37	1,457.49	141	29.6	75,435	5.5	12.7	1.938
1875–'76	18	70.37	1,659.91	204	42.8	10,400	8.3	20.2	1.888
1876–'77	18	70.37	1,497.97	90	20.2	45,000	3.5	10.1	2.422
1877–'78	18	70.37	1,457.49	112	25.2	75,000	4.5	12.5	2.004
1878–'79	19	77.50	1,659.91	160	.....	.....	.....	.....	.....

Through the courteous intervention of Prof. B. Corenwinder, of Lille, France, I have been able to obtain from M. Linard the following statement concerning the cost of establishing the central factories with pipe lines in France:

The expenses of installation of central factories with rasping-works and subterranean transport of juice of beets are very nearly those of ordinary works. Compared with the tons of beets to be worked they are a little lower, varying from 35 to 40 francs ($7 to $8) per long ton. Thus the works at Cambrai, capable of working 200,000 tons of beets, cost 8,000,000 francs ($1,600,000). The crisis in metals at the time these works were constructed had a decided influence upon this cost.

The metallurgical establishment of Marquis sells the pipe at 16 francs per 100 kilograms. The meter of pipe (of 100 millimeters [3.9 inches] diameter) weighs 28 kilograms. The cost of laying complete for this diameter is 1.50 francs per meter. The price varies with the diameter.

The net cost of extraction of the juice is evidently variable with the processes of extraction, and it is the same for rasping-works as for ordinary works.

The advantage of central factories consists in the reduction of costs of every description at the central works and in the reduction of the general costs by half the weight of the beets. Thus at Cambrai we have expended this year 30.80 francs ($6.16) per long ton of beets, including cost of beets, paid for at the rate of 21 francs ($4.20) to the grower. In the next campaign, if we work 200,000 tons instead of 165,000 tons, the quantity worked in the last campaign, the cost per ton will be reduced to 30 francs ($6). I think that an ordinary factory working annually 15,000 tons of beets will expend 34 to 35 francs with our price of beets. With the continuous presses we are trying we shall fall to 28 francs ($5.60).

It follows that central factories less important than that at Cambrai will expend more. That at Origny, which consumes 120,000 tons, has expended 1.50 francs more per ton than ours.

I hope, sir, that this information will be satisfactory.

Accept, etc.,

LINARD.

Linard's figures for cost of constructing pipe lines may be translated as follows:

Pipe 100 millimeters (3.9 inches) diameter weighs 18.779 pounds per foot.
Pipe 100 millimeters (3.9 inches) diameter costs $0.273 per foot.
Laying same complete costs $0.0914 per foot.

Estimates for similar costs in the United States are given as follows:

For pipe:
4-inch diameter, weighing 18 pounds per foot, costs $0.23 per foot.
6-inch diameter, weighing 26 pounds per foot, costs $0.41 per foot.
For laying, filling, calking, fitting, &c.:
4-inch pipe, $0.14 per foot.
6-inch pipe, $0.16 per foot.

From these figures we may estimate the comparative cost per mile of constructing pipe lines in France and the United States, using 4-inch pipe:

	France.	United States.*
Pipe	$1,441 44	$1,214 40
Laying complete	482 59	739 20
Total	1,924 03	1,953 60

*Since this table was constructed in July, 1879, the price of pipe in the United States has advanced (December 15, 1879) at least 75 per cent.

As Linard says, the cost of establishing these lines will, of course, vary with the size of the pipe used. For the United States, supposing 5,000 tons* to be handled at each rasping-works in a year, cost of establishing the pipe line at $2,000 per mile in round numbers, and interest, &c., at 10 per cent. per annum, the cost of transporting the juice by this system would be 4 cents per mile per ton of beets worked, and this

*But for so small a quantity as 5,000 tons per annum a much smaller pipe, half the diameter, could be used, and the cost of establishing the line would be reduced in consequence by about 30 per cent.

rate would be reduced in proportion to the increase over this quantity in the beets worked.

It would appear from what has been stated that besides the profit to be derived from working larger quantities of juice under the same administration, no appreciable saving would be effected in the United States in the cost of transportation, except in the event of working at the rasping-works over 5,000 tons of roots. But it must not be forgotten that this system leaves behind all the pulp, amounting to at least 20 per cent. the weight of roots, for which the cost of return transportation to the farmer will be saved.

The following information I have been able to obtain through the courtesy of M. Henri Vilmorin concerning the central factory at Meaux:

The cost of working proper amounts to 36 to 37 francs ($7.20 to $7.60) per ton; it amounts to 40 to 41 francs ($8 to $8.20), including interest on capital and redemption (*amortissement*).

The total length of pipes is 90 kilometers (55.8 miles). The diameter of the pipes is variable according to the place, the pipes of several rasping-works flowing into the main pipe, that must of course be larger. The smallest are 10 centimeters (4 inches) in diameter, and the largest 20 centimeters (8 inches).

The cost of laying the pipes, 0.40 franc per meter ($0.093 per yard) for the smaller, and 1.50 franc per meter ($0.274 per yard). The total cost per kilometer amounts to 7,000 francs ($1,930.80) per mile.

The juice runs, or rather is forced through the pipes at a speed of 10 to 15 meters (12.8 to 19 yards) per minute. The cost of working the pumps is only 3 to 4 centimes per ton of juice, but the main expense is derived from the interest on the capital invested in the rasping-works and pipes. Of the total expenditure at Meaux (5,800,000 francs = $1,160,000), one-third at least is invested in rasping-works and pipe-lines.

The cost of carting the roots would amount to about 0.50 franc (10 cents) per ton per kilometer (equivalent to 16 cents per mile); but it must be borne in mind that it is impossible to have roots carted to the factory from a greater distance than 5 or 6 miles (8 to 10 kilometers), while the factory at Meaux requires an amount of roots or juice not to be found within that distance. It is only by means of the rasping-works and pipe-lines that they can obtain a supply of roots.

The total amount worked has been as follows:

	Tons.
1876–'77	79,504
1877–'78	90,436

The factory is intended to work 100,000 tons a year, but they have never succeeded in securing so large a supply.

The proportion of sugar obtained has been, in 1876–'77, 5.81 per cent. of the beets worked; in 1877–'78, 7.87 per cent. of the beets worked, the roots being unusually good in the latter year.

The systems for extracting the juice is the next branch of the work under the direction of the manufacturer to which intelligent and successful effort has been directed to secure economy in the time and means for extracting the sugar from the root. In France that which until later years has found greatest favor and widest application consists in a combination of the rotary rasp, after the invention of Lampadius, for reducing the root to pomace, and the hydraulic press of ordinary construction for expressing the juice. But this system involves the em-

ployment of large numbers of workmen, which it has become the desire and the necessity of the manufacturers to avoid, and the improvements that have been brought to bear upon it depend for their value upon their automatic functions, by which the suppression of manual labor is effected. But before proceeding to the discussion of the means referred to for suppressing manual labor, it will be proper to call attention here to the means devised for increasing the effective power of the hydraulic press, the most important of which seems to be that of Gallois, depending upon the principle developed by others working with the continuous presses that the juice of the root liberated from the cells cannot carry out all of the sugar under pressure, and that much is lost by mechanical adhesion. His idea was, therefore, to wash the sacks from the preparatory press with a small stream of water, amounting in all in the operation to about 15 per cent. of the normal juice obtained. The water is made to flow automatically upon the center of each sack as it is put in place on the hydraulic press from the preparatory press. It has been found more efficacious to use hot than cold water. The water becomes slowly diffused through the thin layer in the sack and thoroughly washes the mass.

It in no way affects the quantity of pulp produced, but reduces the proportion of sugar left behind by about 1.7 per cent.; that is, the experiments of Gallois prove that for each 100 pounds of beets worked he was able to save 0.39 pounds of sugar, amounting to 39 sacks of 220 pounds each, for each 10,000 tons of beets worked, and this quantity in France is worth 2,000 francs ($400). The cost of evaporating the extra water added is estimated at 300 francs ($60).

Viviens* analyses of pulps obtained in the application of Gallois' method for washing the pulps in the hydraulic press and with the hydraulic press alone showed that with washing the loss in sugar was 0.867 per cent. of the beets worked, while the pulps not washed carried away 1.28 per cent. of the beets handled.

Lalouette conceived the idea of surrounding the movable platform of the hydraulic press with a chest made up of strong vertical iron bars placed very closely to each other and lined inside with a strong perforated metallic sheet generally of copper. The press has the advantage of suppressing part of the manual labor, as no sacks are required, they being replaced by simple small sheets or towels which serve to divide the charge to the press into layers, but in order to render the press completely effective second pressing must be resorted to. In order to render the work more automatic, therefore, this press is used in connection with filter presses, into which the pomace from the rasp is forced by means of a strong force-pump. By this means 60 per cent. of juice is obtained. The filter presses are so arranged that the pulp from them falls directly into the chest of the Lalouette press, and much handling

* *La Sucrerie Indigène*, xii, 350.

is in this way saved. Before the second pressing, the pulp may be mixed with a small quantity of water, and such treatment has been found of great advantage. But even without this treatment it is claimed that the loss of sugar in the pulp amounted to only 0.825 per cent. of the weight of the beets worked.

Each of the filter presses has a capacity of 40 tons per day, and each Lalouette press the pomace of 15 tons of roots or the pulp of 30 tons. The system requires no handling at preparatory presses, filling of sacks, &c., and, it is claimed, requires only about 40 per cent. the number of laborers employed with the ordinary hydraulic press, increases the yield of sugar, and reduces the yield of pulp to 17 to 18 per cent. of beets worked.

The filter presses referred to vary in design according to the maker or inventor, but all are based upon the same principle of a series of gridiron-shaped frames, the faces of which are covered with a filtering surface of linen or jute cloth. These frames are arranged parallel to each other upon a strong support, and are brought into close contact by means of a screw-press fixed to one end of the support. The material to be filtered is forced between the frames through a passage along the side or through the center and distributes itself over the filtering surface; the liquid portion finding its way into the interior of the frame is drawn off at the bottom by means of a stop-cock attached to each one, while the solid portion is held back between the filtering surfaces. When the press is fully charged, the pressure holding the frames together is removed, the frames separated, and the pulp allowed to fall into a recipient underneath. If necessary, the cloth is cleaned by means of a brush or other suitable instrument.

But the combination of the hydraulic press of Lalouette and the filter presses just described is not as effective in saving labor as the continuous presses are claimed to be. These latter seem to reduce the labor required to a minimum, and, with the improvements lately introduced in their construction and management, they seem to be about as effective in extracting the juice as the other systems of presses employed, and depend in principle upon the application of rolling cylinders variously constructed.* While we do not intend entering here into detailed descriptions of the different continuous presses, or other means of extraction that have been invented and employed, we consider that attention should be called to them on account of the interest that has been manifested concerning them among the sugar manufacturers of France, and that brief notices of them here will be of value to those desiring to enter into the manufacture of beet-root sugar in the United States, or as a source of preliminary knowledge, at least, to those who may be interested in the progress of the industry abroad.

The cylinders of these presses are constructed either with apertures

* With the exception of the Pièron screw press.

perforating their rolling surface, so that the juice is caused to pour into the interior, from which it is allowed to escape, as in the presses of Champonnois and Lebée, or the pulp is carried, by means of endless belts of linen or jute, between a series of solid rollers, effecting a gradually increasing pressure, as in the presses of Poizot and Manuel and Socin.

The presses with rolling cylinders having perforated surfaces are modelled after that of Pecquer, who seems to have been the first to apply this system in the industry. In his press the cylinders are partly inclosed within a closed chest, into which the pomace is forced by means of a strong pump. The surface of the cylinder is merely perforated with small round holes, but this was found subject to serious objection on account of the quantity of solid matter that was allowed to pass through with the juice, which it was difficult to remove by means of filters. Champonnois and Lechaume improved upon this press, following the same principle, and covered the surface with longitudinal openings in the direction of the circumference; and into these openings, which are suitably prepared to receive it, and passing around the cylinders spirally, triangular wire is wound so closely as to present an almost perfectly smooth surface. The openings for the passage of the juice are formed by very slight elongation of the wire, due to the pressure to which it is subjected. As in the Pecquer press, the pomace from the rasp is forced, by means of a strong press, into a close box which covers about two thirds the filtering surface of the cylinders. The axes of the cylinders are inclined about 45 degrees to facilitate the removal of the pulp.

The Lebée press is based upon the same principle; the cylinders are partly inclosed, but the filtering surface is of different and perhaps simpler construction. It is made up of a series of movable frames, which may be changed at will, consisting of small narrow bars, about 0.05 inch wide, separated from each other by an interval of about 0.004 inch. These small bars are soldered together in sets, so that any injury to the filtering surface may readily be repaired. In the Champonnois press the exhaustion of the pulp was not sufficiently complete by means of single pressing, and it was found necessary to resort to double pressing, involving the use of two or three machines to secure continuous operation, but in the Lebée press this work is automatically effected in the same machine, by means of a combination of several cylinders. After passing between the first set of filtering cylinders, the pulp passes under a solid cylinder, rolling upon one of the filtering cylinders, after which it is treated with a spray of water, and again passed under solid cylinders, rolling upon another filtering cylinder. By this means the exhaustion is not only accelerated, but it is claimed to be rendered more complete.

In the Collette press the filtering surfaces consist of sheets of finely perforated copper, fastened only at one end, along the length of the

cylinder, so that the other being left free may not be injured on account of any extension produced by the pressure to which it must be subjected. These sheets are therefore capable of being easily and readily removed for repairs. In other particulars the press is very similar in construction to that just described.

In the Dujardin press, lately invented, the cylinders are covered with heavy brass sheeting about .08 inch in thickness. The openings made in this metallic sheet are cylindrical for a short distance, about 0.26 inch, after which they expand conically toward the under side, and by this means the difficulty of choking the holes is avoided. By a special machine used by M. Dujardin for piercing the sheets, he is enabled to make the apertures closer to each other than is obtained by other manufacturers in sheets of this thickness.

The principal difficulty encountered in the application of these different presses is found in the very large amount of pulp that passes into the juice and is found difficult to separate by means of the filters that have been devised for the purpose, but this difficulty has been materially reduced by the adoption of the process of adding a small proportion of milk of lime to the juice previous to filtration. This treatment seems to have a tendency to render the solids more dense and less liable to choke the apertures of the filters, whether rotary or of other design.

The same difficulty is found in the use of the other continuous presses to which we are about to call attention, but in a less degree. In these the filtering surface is generally of flax or jute cloth, made in endless bands, and there is less liability of the small particles of pulp passing through them. All of them depend upon the principle of subjecting the pomace to a gradually increasing pressure by passing between different series of rollers, and carried between endless belts of the material mentioned above. The first of these presses is stated by Basset to have been devised in 1812, but Poizot seems to have been the first to make an effective one, and to apply it in industrial work.

That described by Basset consists simply of an endless sheet carried between two rollers held in contact with each other by means of levers to the further end of which weights are attached. The material is distributed upon this belt and is carried by it between the rollers. Poizot's press is a great improvement upon this simple means of extracting the juice. In his first designs he made use of two belts which were made to pass between the same rollers, the pomace being distributed between them. The belts were carried around a large cylinder against which a series of smaller rollers is forced with gradually increasing pressure. After passing these smaller rollers the belts are subjected to further pressure by means of another cylinder of the same size as that at first mentioned, and rolling against it. The exhausted pulp is discharged on the other side of the last cylinder and the belts cleaned by means of beaters. In the presses of later design only one belt is em-

ployed. The pomace is distributed upon it and it is caused to pass over the smaller rollers, being brought into direct contact with the larger roller. The pulp falls from the belt after passing between the larger rollers, and is collected in a recipient below. In later days, when it has been found that work with all presses may be rendered much more effective by mixing the pulp with a certain proportion of water and repressing, the pulp from Poizot's press of latest design falls into a mixer into which a constant spray of water flows, and it is here thoroughly mixed with the water and distributed at once to the belt of a second press. This preparation for second pressing is an entirely automatic operation, and the two presses and the mixing may easily be superintended by the same individual.

The Manuel and Socin press depends upon the same principle, but the system of rollers is arranged horizontally and consists of five pairs of cylinders of the same size. The distance between the cylinders of each pair varies respectively according to its distance from the point of supply. The pressure exerted by each pair of rollers is governed by a strong steel spring the power of which may be increased or diminished at will by means of a screw regulator.

The Leroy press is described by a writer in *La Sucrerie Indigène* (XII, 367) in the following terms:

> The Leroy press, constructed by Messrs. Mariolle Brothers, of Saint Quentin, is provided with rollers and an endless sheet upon which pulp is distributed by means of a special apparatus called the *preparateur*, founded upon the same principle as the press properly so called; that is to say, in the preparateur the material coming directly from the trough of the rasp and equally distributed upon an endless sheet is submitted to an energetic preparatory pressing by means of a series of rollers gradually approaching each other more and more in such a manner as to distribute upon the press only pulp partially exhausted of its juice.
>
> The endless sheet is here a thin sheet or steel pierced with a large number of small holes, forming the filtering surface for the juice. In the press the endless sheet is of the same nature, but it is doubled, as it were, by a woolen sheet, upon which the pulp to be pressed is distributed. Good filtration of the juice is thus assured, and at the same time almost all the fatigue is referred to the metallic sheet. This steel sheet is very useful, and the price is not very high. It is, besides, easily repaired in case of accident.

Mons. V. Pièron has devised a press that is more simple in construction than any yet described. It consists of a screw arranged horizontally within a perforated cylinder of copper, and the whole hermetically inclosed in an envelope of cast iron provided with internal channels for flow of the juice. The blades of the screw are of copper, and the axis of bronze. The blades are in sections, and may readily be removed and cleaned. The pulp to be pressed is forced into the cylinder by means of a strong pump, and is carried by the revolving screw toward the other end. When it first enters the press the pulp is submitted to very slight pressure, but the pressure increases as the pulp approaches the other end, where it is forced out through a valve so arranged that

the discharge of pulp may be regulated at will. A portion of the axis of the screw is hollow, and the portion beyond the discharge orifice connects with the water supply, so that a small quantity of water may be continuously added to the pulp at the latter part of the pressing to effect a saving in the sugar that would otherwise be left in the pulp.

To secure effective work with this as with other continuous presses, the method of double pressing must be employed, and for ordinary working 6 presses are used for the first pressing, and 2 for the second pressing. For the first pressing the motive force required by each press is 1½ horse-power, and for the second 2 horse-power. The advantages claimed for the press is its solidity, slight liability to accident and repairs, and small amount of labor required in their management. The work of grinding and pressing being altogether automatic, one man can attend to both operations. There is no opportunity for the juice to come in contact with the air between the press and the liming-vat, and there is consequently little or no change. The pulp of the first pressing contains 80 to 83 per cent. moisture, and 7 to 9 per cent. of sugar; and that of the second pressing contains 4 to 5 per cent. of sugar. The final pulp represents 26 per cent. of the beets worked.

On account of the advances it is making in France, the process of diffusion invented and applied by Robert, of Seelowitz, in Austria, merits some attention here. It finds favor among manufacturers on account of the reduced cost of working as regards the employment of manual labor, and the larger proportion of sugar it is claimed may be extracted from the pulp. But the apparatus of Robert has been somewhat improved upon with regard to rendering the process more automatic by placing the diffusers in a circle upon a platform, to which a rotary motion may be applied. They are so arranged that the root-cutter may be placed upon a floor above, and the slices charged directly to each diffuser in turn as brought in place, with no extra handling. Georges Dureau, writing of this improvement, and quoting Dantzenberg, says:*

Desirous of effecting more rapid work than otherwise, and at the same time doing better work, there has been constructed a diffusion battery, charged directly from the root-cutters. For this purpose the diffusers are placed upon a movable base and under the root-cutter, so that the slices may fall directly into the diffusers like rain, in such a way as to distribute themselves in the best possible manner for the circulation of the juice. The diffusers are animated by a rotary movement, which may be made so slight that when we wish to work 240 diffusers per day the rapidity of motion on the circle will not pass $3\frac{1}{2}^{mm}$ per second. It will therefore be seen that the rotary movement will not interfere with the manipulations.

It follows, from the mechanical movement, that the interval from charging the diffusers and the different operations up to the discharge is exactly determined. The spaces of time for each diffuser are exactly the same, and the workmen must absolutely follow the rapidity of the apparatus. The manufacturer needs, therefore, to place no dependence upon the laborers. He may fix the duration of diffusion and make the number of diffusers he desires. On the other hand, the *personnel* is reduced in most factories by about eight men.

* *Journal des Fabricants de Sucre*, July 24, 1878.

The tubes for juice, water, and steam are placed in the interior of the circle of batteries, and facilitate by their short length the flow of juices. The space occupied by the system is limited, and this is particularly important for those who desire to remove their hydraulic presses. Besides, the cleanliness of the works is always absolute. Means for closing the doors of manholes have been invented applicable to all sizes.

It is in Austria that the process of diffusion has found widest application and has made the greatest advances. Thus in 1867 there were 114 factories with hydraulic presses, 3 with centrifugal filters, 2 with maceration, and 2 with diffusion.

In 1876 to 1877 there were 30 factories with hydraulic presses and 181 with diffusion.

Each diffuser of 750 gallons is supposed to handle about 6½ tons in twenty-four hours, and a battery of 10 would therefore be capable of working 65,000 tons or more per annum.

In France it is stated that during the present season (1879) as many as fourteen or fifteen works will introduce the diffusion process, in addition to the five or six already having it in operation. It is considered that but for the high price to be paid for the patent rights and the present depression of the sugar industry in France the method would extend much more rapidly.

It is stated that the process of Robert requires not more than five or six workmen to manage it, but it is claimed that by means of the rotary arrangement of the diffusers mentioned above this number is reduced to two or three. It is also claimed that the process will secure to the manufacture an increase by about 1 per cent. in the amount of sugar obtained.

One of the objections urged against the process has been the time required to extract the juice, but this difficulty has been to a great extent remedied by application of heat to the water employed in the diffusers, or to the material itself in the diffusers; but while this reduces the time for extracting the sugar from the slices, it also carries out a larger proportion of organic matters and salts, which have the well-known tendency to increase the proportion of molasses obtained at the cost of the yield of crystallized sugar.

It would be of interest and importance to note the comparative value of the different methods we have described, and we give below some of the figures by which this may be determined. The value will depend upon the cost of apparatus, the labor required in management, the steam force employed, the quantity of material that may be handled in a given time, the degree of extraction of sugar, the total cost, and the value of the residues.

With the limited time and means at my disposition while in France it was impossible for me to obtain complete data bearing upon these points, yet it would appear that, all things being considered, power and labor required and convenience of management, some of the continuous presses will find favor among American manufacturers who may desire

to attempt the introduction of this industry, which has proven such a valuable source of profit to both the capitalists and the laboring classes of France and other portions of Europe. In this connection however, the conclusions arrived at by M. Durin* in his discussion of the efficacy of the processes of extraction by means of hydraulic presses, continuous presses, and diffusion will doubtless be of interest. He finds that:

By hydraulic presses, with beets of 10 to 10.50 per cent. sugar without washing or maceration of the pulps, the loss of sugar in extraction per 100 pounds of beets may be valued at 1.70 to 1.75 pounds. This loss would be greater with very rich beets and less with poor ones.

By continuous presses, and kneading at a temperature of 50 to 55° C. during 10 minutes, with a quantity of water equal to 120 to 140 per cent. the weight of the pulp of the first pressing, and working beets of 11 to 12 per cent. of sugar, the loss in extraction per 100 pounds of beets is 1 to 1.10 pounds of sugar.

By diffusion the total loss in extraction per 100 pounds of beets is 0.50 to 0.55 pound of sugar, and by compressed air this may be reduced to 0.35 to 0.40 pound. The juice of diffusion is purer with regard to saline and organic matters than juice from the presses.

But Champonnois,† comparing the results obtained by diffusion and continuous presses, and taking the figures given by Walkhoff and those published by Vivien for the efficacy of the diffusion process in Germany, and the figures obtained by double pressing with the continuous presses in France, deduces the following table:

Diffusion.	Percentage sugar in beet.	Proportion of the sugar present extracted.
Vivien, diffusion	12.4	70
Walkhoff, diffusion	10.0	66.3
Do	13.50	66.66
Continuous presses	11.20	66.69
	12.00	68.33

The higher yield in the second case with continuous press is the result of hot maceration before second pressing. And according to Vivien, the loss per 100 pounds of beets worked by the continuous press of Manuel and Socin after second pressing was but 0.925.

The farmers to whom the residues of the factory having a feeding value must be returned to be utilized will naturally inquire which of the processes mentioned will yield a pulp that will give the highest net return in meat or milk. This matter has been pretty thoroughly determined as regards the residues from the hydraulic presses and the diffusion processes, but concerning the residues from the continuous presses such information is wanting. If, however, we make allowance for about 10 to 12 per cent. more of water, the latter contain, their average composition must be much the same as the pulps from the hydraulic presses. In an article on "Beet-root pulp," Professor Voelckler, of Lon-

* *Journal des Fabricants de Sucre*, April 16, 1879.

† *Journal des Fabricants de Sucre*, March 28, 1878.

don, gives the results of his analyses of this product from various sources, and we have collected them in the following table:

	Pulp from Lavenham, England.	Pulp produced in France.	Pulp produced in France.	Belgian pulp one year old.	Average composition of beet-root pulp.
Moisture	70.11	70.88	77.10	70.00	70.00
Albuminous compounds* (flesh-forming matters)	2.25	2.38	1.93	2.43	2.5
Sugar	3.39	.....	.....	.....	1.5
Mucilage and pectinous compounds	1.93	†6.59	‡1.19	.....	.....
Digestible cellular fiber	15.13	.....	.....	§18.67	.....
Woody fiber (cellulose)	5.32	.....	.....	6.48	.....
Crude cellular fiber	.....	16.43	16.07	.....	‖24.00
Lactic acid	.....	.....	1.12	.....	.....
Mineral matter (ash)	1.87	3.72	2.59	2.42	2.00
Total	100.00	100.00	100.00	100.00	100.00
*Containing nitrogen	0.361	0.382	0.39	0.39	0.40

†Containing a little sugar.
‡Including sugar.
§Including pectinous compounds, &c.
‖Including a little lactic acid.

The following will show the results of Corenwinder's analyses of French pulps from the hydraulic presses:

Water	71.240
Sugar	3.620
Fatty matter	0.628
Cellulose	10.345
Albumen	2.381
Pectose, &c	9.434
Mineral matters	2.172
	100.000

In this connection the following abstracts from the tables of Settegast, in his work *Die Thierzucht*, quoted by Graudeau in his *Instruction pratique sur le calcul des rations alimentaires des animaux de la ferme*, showing the composition of various residues from the sugar-factory having a feeding value, and of few varieties of hay, will be of interest and value.

RESIDUES FROM SUGAR FACTORY.

	Water.	Nitrogenous matters.	Crude fatty matters.	Non-nitrogenous extracted matters.	Crude cellulose.	Ash.	Nitrogenous matters : non-nitrogenous matters :: 1 : —
Beet-root molasses	18.33	8.67	.....	63.03	.....	9.97	7.2
Residues from presses	71.77	1.91	0.42	17.24	5.59	3.07	9.2
Residues from centrifugal process	82.0	1.0	0.1	12.1	3.6	1.2	12.2
Residues from diffusion (fresh)	92.86	0.59	0.08	4.01	1.71	0.75	7.1
Residues from diffusion (pressed)	88.08	0.97	0.12	7.19	2.33	1.31	7.5
Raspings of beets	82.91	1.28	0.11	10.42	3.98	1.30	8.2

DIFFERENT KINDS OF HAY.

	Water.	Nitrogenous matters.	Crude fatty matters.	Non-nitrogenous extracted matters.	Crude cellulose.	Ash.	Nitrogenous matters: non-nitrogenous matters :: 1 : —
Meadow hay	14.59	10.11	2.34	40.90	25.52	6.54	4.2
Ray grass	11.23	8.0	2.80	44.58	25.45	7.95	5.9
Timothy	14.3	9.7	3.0	45.8	22.7	4.5	5.0
Red clover	18.38	12.97	2.18	36.16	24.45	5.86	2.9
Lucerne	15.07	14.76	3.02	35.65	24.08	8.42	2.5
Blue grass	14.3	8.9	2.3	39.1	32.6	5.1	4.6
Average of all grasses	14.3	9.5	2.6	41.7	28.7	5.8	4.66
DISTILLERY REFUSE.							
From corn mash	90.61	1.98	1.04	4.95	0.99	0.43	.....
From rye mash	92.16	1.64	0.34	4.30	1.17	0.39	.....
From beer mash	96.74	0.73	2.08	2.08	0.32	0.13	.....

From this it would appear that in order to secure in pulp from the presses the equivalents of hay from the sources mentioned there will be required—

	Tons pulp.
For 1 ton clover hay	$2\frac{1}{2}$
For 1 ton timothy hay	$3\frac{1}{3}$
For 1 ton average of all grasses	3

With a crop of 20 tons of beets per acre, therefore, the yield in feeding material is by no means insignificant.

Now, concerning the relative value of pulps from the presses and diffusion, we may quote a review of the late work of Dr. Petermann, the able director of the agricultural station of Gembloux, bearing upon this subject, and published in the *Journal d'agriculture pratique*, 1879, p. 13:

These residues are far from having the same value according as the beets are treated by the ordinary method (with presses), or by the system of diffusion. In the first case, the roots being submitted to rasping, the cells are torn, and the saline and albuminoid matters are mixed up with the sugar in the juice by the action of the press. In the second case the cells are preserved intact in cutting the beets in thin slices, to be exhausted with tepid water. The residues from diffusion are almost free from sugar. If in the dry state they are more rich in albuminoids; in the fresh state they contain a larger proportion of water and are much less nutritive, as the following analyses by Dr. Petermann will show:

Composition.	Diffusion.		Ordinary press.	
	Fresh pulp.	Composition of dry matter.	Fresh pulp.	Composition of dry matter.
Water	89.91	.....	72.48	.....
Albuminoid matters	1.08	10.70	2.18	7.92
Fatty matters	0.08	0.79	0.30	1.09
Non-nitrogenous extractive matters	6.13	60.76	15.93	58.08
Mineral matters	0.72	7.14	3.29	11.87
Cellulose	2.08	20.61	5.79	21.04
	100.00	100.00	100.00	100.00

Dr. Petermann says that, "Comparing the residues of diffusion with those of the presses, we see that the first are much more watery and less rich in nutritive principles than the latter. Therefore, the cultivator cannot expect from an equal weight of slices and of pulps the same effect in fattening. By 1,000 pounds of the residues of diffusion he acquires in round numbers only 10 pounds of albuminoid matters, 1 pound of fat, and 61 pounds of non-nitrogenous extractive matters, while in the residues from the presses he will furnish his cattle with 22 pounds albuminoid matters, 3 pounds of fatty matters, and 160 pounds of non-nitrogenous extractive matters. The grower should not therefore pay for the slices (containing 90 per cent. of water) more than half the price he pays for the pulps of ordinary presses."

But the system of diffusion constitutes a manifest progress, not only in an industrial but also in an agricultural point of view, a progress which should be considered in comparing the two above analyses giving the composition of the dry matter. In fact (we quote textually from Dr. Petermann) it preserves to agriculture, and in the form of a suitable food, the millions of tons of albuminoid matters, which, in the work of the presses, are lost to it, or of which only a small proportion is restored in the scums. Thus a factory which works, according to the old system, 20,000 tons of beets restores to agriculture 3,500 tons of pulp, or, according to our analyses, 76.3 tons of albuminoid matters, while if it adopts the system of diffusion it produces 14,000 tons of pulp, which, holding 1.08 per cent., contains 151.2 tons of albuminoid matters. The 20,000 tons of beets which agriculture has furnished to the industry contain 200 tons of albuminoid matters. In the first case the loss is 200—76.3=61.8 per cent.; in the second case, 200—151.2=24.4 per cent. If we apply these results to the calculation of the production of an entire country we recognize how much the interests of agriculture are allied to the progress realized by the sugar-producing industry.

Dr. Petermann recommends that farmers take into account, in the calculation of their rations, the difference between the composition of ordinary pulps and pulps from diffusion. They should also associate with the latter a larger proportion of dry fodder, in order to avoid the inconveniences which result from too watery food.

The feeding values of residues from the two processes mentioned for extracting the juice have been determined by direct experiments by Mr. Simon Legrand at Bersee (Nord), and we give below the results he obtained. They show that if the modification in price recommended by Dr. Petermann be allowed, the profits secured by fattening cattle are greater by use of residues from diffusion than with residues from the presses, and with an equal expenditure of money the fattening is much more rapid.

Comparative table of feeding cattle with pulps from hydraulic presses and those of the diffusion process on the farms of Simon Legrand.

	Pulps.			
	Hydraulic presses.		Diffusion.	
	Oxen.	Bulls,	Oxen.	Bulls.
Number of animals	40	20	40	20
Date of entry to stable	March 15, 1878.		November 9, 1878.	
Average weight on arrival, per head ..... pounds..	1,086	1,018	1,166	1,122
Purchase price, per head ..... dollars..	101.35	69.05	104.95	77.20
Net cost, per pound ..... cents..	9.3	6.8	9.0	6.8
Food:				
Pulp (at $4.40 per long ton and slices at $2.50), per head and per day ..... pounds.	99	99	165	165
Linseed cake (at $2.18 per hundredweight), per head and per day ..... pounds..	4.91	4.91	4.91	4.91
Hay (at $0.637 per hundredweight), per head and per day ..... pounds..	3.3	3.3	3.3	3.3
Cost of food, per head and per day ..... dollars..	0.33	0.33	0.316	0.316
Cost on leaving, per head ..... do...	136.66	104.35	134.64	106.90
Days in stable from arrival to departure	107	107	94	94
Date of departure	July 1, 1878.		February 11, 1879.	
Excreta, at 10 cents per head and per day ..... dollars..	428	216	376	188
Average price of sale, per pound live weight ..... cents..	9.8	9	10.5	9.25
Average weight on leaving, per head ..... pounds..	1,439	1,375	1,468.5	1,879.4
Average value on leaving, per head ..... dollars..	150.99	123.20	149.55	125.40
Result, per head, profit ..... do...	14.33	18.84	14.91	18.50

Among French farmers it is considered much better to feed the pulp to sheep and cattle for production of meat than for milk. Horses will not eat it. The daily rations of beet pulp given to sheep and cattle vary, but the amounts generally considered most favorable are about 5 pounds per head for sheep and 50 pounds for cattle, in admixture with hay, seed-cake, corn-meal, or other food. The pulp is stored for preservation in trenches or *silos*, and for this purpose it is mixed with about one per cent. its weight of salt to prevent it from entering into putrefactive fermentation.

But the other residue of the factory, the molasses, has always been a source of loss, and to such an extent that it may be considered the bane of the manufacturer. To obviate this loss and to secure in the factory the sugar that now finds utilization in the distillery has been the subject of close study and the basis of innumerable experiments, some of which have given fruitful results; and in later days some of the methods devised bid fair to find industrial application and to do exceedingly economical work.

It is scarcely necessary here to call attention to the method of Dubrunfaut and others for separating the mineral impurities, which have such a deleterious effect upon the crystallization of the sugar, by taking advantage of the principle of osmosis, for this method has long been known and has been applied with tolerable success in the factories of the European continent. But we may call attention to a modification in the application of the process, which appears to be an improvement, and which is based upon increasing the colloidal properties of the cane-sugar, thus preventing its passage through the dyalizing membrane, or

at least reducing its power to pass through. The modification consists in the addition of a small quantity of milk of lime to the juice before it passes to the dialyzer, and is said to produce a wonderfully good effect. It has also been found of great advantage to increase the temperature during the process. By these improvements it is claimed that the work is more rapid, there is a minimum loss of sugar, and the liquid obtained is much purer.

But the latest methods which have been devised, and which are attracting great interest in the sugar manufacturing circles of Europe, are those based upon treatment of the molasses with lime in various ways for the production of a basic sucrate, which may be freed from the mineral and organic impurities by washing with alcohol or hot water, and worked through the regular processes in the factory for separation of the sugar after saturation with carbonic acid.

These new methods are styled *elution* or *substitution*, according to the mode of applying the lime and treatment of the sucrate obtained. The elution method consists of adding quick lime to the molasses in quantity sufficient to produce a pasty mass, which becomes very hot, and upon cooling hardens; or slaked lime is employed, and the mixture heated to a temperature of about 220° Fahr. The sucrate formed is broken into lumps and treated with successive portions of dilute alcohol to separate the alkaline salts and other mineral or organic impurities, and the purified compound after being freed from alcohol is sent to the saturation pans to be worked with the juice from the presses or by itself, as the case may be.

The substitution method depends upon the insolubility of the sucrate of lime in hot water. In practice, a quantity of thin milk of lime is added to the diluted molasses in quantity slightly in excess of that required for the formation of the sucrate, and the whole heated in closed vessels under pressure and at a temperature of 220° to 230° F. When the sucrate is formed the hot mixture is passed through filter-presses and the solid matter separated. Each time only about one-third of the sugar contained in the molasses and the mother liquor from the filter-presses, after addition of molasses, is treated a second time. The mother liquors are thus returned and successively treated until they contain about as much of potassic salts as the residue (*vinasse*) from the distillery, when they are discarded to be employed for the extraction of the potash or for direct utilization as a liquid potassic fertilizer. It is claimed that sugar remaining in the waste liquor represents about 6 per cent. the weight of the molasses treated. Dr. Stammer, the great German authority on sugar manufacture, considers this latter method the most efficacious and economical of any yet devised for separation of the sugar from the molasses. This view is, however, stoutly combated by the inventors of the elution method.*

The sucrate from the filter-presses, like that from the other processes,

* See *Journal des Fabricants de Sucre*, August 20, 1879.

is mixed with the juice from the presses in the saturating-pans or is worked by itself. It is suggested that the method may furnish work for the factories during the idle months.

The methods thus briefly described have not yet been extensively introduced in the factories of Europe, but they bid fair to bring about important modifications in the modes of utilization of the molasses to the profit of the sugar manufacturer, and special inquiry concerning them will doubtless be of interest and value to those engaged in the sugar industry.

Those who may be inclined to invest their capital in establishing factories for extracting the sugar from beets in this country will naturally inquire what will be the amount of money required and the average cost of working, and I have endeavored to obtain as far as possible the necessary data, but I am quite aware that the figures I am able to present are in many respects incomplete. They will not, however, be without interest and value.

It is a generally accepted fact that the smallest quantity of beets that can be handled each year with profit is about 6,500 tons, requiring a factory capable of working up about 50 tons of roots per day of 24 hours. To erect and equip a factory of this capacity in this country would cost, in round numbers, about $55,000. I shall not give here the details of this estimate, because in most cases it will be found more advantageous to establish on a larger scale, and the estimates I have therefore prepared are for factories capable of working 100 tons of roots in 24 hours, or from 10,000 to 12,000 tons per annum (or working season of about four months). The figures I have been able to obtain in this connection are as follows:

Estimate of cost of machinery and apparatus for a beet-sugar factory capable of working 100 *tons of roots in* 24 *hours.*

EXTRACTION OF JUICE.

(*a*) By Manuel & Socin continuous presses:

1 root-elevator with gutta-percha belt, complete	$460
1 root-washer, complete	776
1 root-rasp, with two drums 12 inches diameter; independent movement of plungers and patented pulp-strainer	798
1 extra drum, complete	189
3 extra boxes, complete	53
1 pulp-trough	85
1 pump for pulp, with 2 cylinders 6¼ inches diameter, 10-inch stroke	945
2 Manuel & Socin continuous presses, with perforated cast-iron rollers, each $2,940	5,880
1 screw-conveyor for conducting pulp to receiving-vat, about	180
1 non-condensing engine, 12½-inch cylinder, 24-inch stroke	1,386
1 transmission of power, complete, about	1,220
Total approximate cost of Manuel & Socin continuous presses, with requirements and accessories	11,972

(*b*) With Piéron continuous presses:

1 horizontal engine, 18-inch cylinder and 36-inch stroke, complete	$1,700
1 elevator and root-washer and stone-separator combined, complete	700
1 rasp, with 2 drums, automatic plungers and oiling-boxes, pulp-trough, and extra drum, complete	700
1 continuous preparatory press, Piéron system	900
5 Piéron continuous presses, 2 for second pressing, at $700 each	3,500
2 closed screw-conveyors between presses for first and second pressing, with elevator, complete	480
1 open screw-conveyor, for removal of pulps for their discharge from press, about	280
1 screen for retaining foam on juice	360
1 pump for injection of water to press	100
Transmission of power to rasp and presses, about	700
Copper tubing connecting the continuous presses	240
Total approximate cost of Piéron continuous presses and requirements and accessories	9,660

(*c*) With hydraulic presses:

1 root-elevator	460
1 root-washer	776
1 rasp, 2 drums 12½-inch diameter	798
1 extra drum, complete	189
2 self-oiling boxes (extra)	53
1 pulp-vat	85
1 mechanical filler (*pelleteur*)	126
1 mechanical preparatory press	504
6 hydraulic presses, cast and wrought iron, with piston 12 inches diameter, each $420	2,520
1 battery of injection-pumps, with 6 cylinders for 6 presses	1,156
1 non-condensing engine, 12½-inch cylinder, 24-inch stroke	1,386
Transmission of power, about	1,220
Approximate cost of hydraulic presses and accessories	9,273

(*d*) Robert's diffusion process:

1 root-elevator	460
1 root-washer and stone-separator, complete	856
1 root-cutter, horizontal plate, 4½ feet diameter; 24 boxes of knives, of which 16 are for exchange	735
10 diffusers, each of 440 gallons capacity, capable of holding 2,640 pounds per charge, each $504	5,040
10 heaters (*calorisateurs*), with 5 feet 10 inches steam coil, valves, stopcocks, tubing, and accessories for connecting with diffusers, each $252	2,520
Girdled iron tubing, adherent to the battery of diffusers, about	560
Copper tubing for conveying steam to and from diffusers, about	300
1 wagon of perforated plate, with circular track	320
1 elevator for exhausted slices, complete	525
2 Klusemann's presses, for slices, each $525	1,050
1 reservoir for compressed air, with tubing, safety-valves, &c., complete	126
Transmission of power, complete, about	1,000
1 pump for compressed air, 10¼-inch cylinder, 12-inch stroke, with special engine, of 9-inch cylinder and 12-inch stroke, complete	1,050
Total approximate cost of apparatus and requirements for Robert's diffusion process	14,552

(*e.*) Rotary diffusion battery, capacity 140 to 150 tons of roots in 24 hours:	
1 root-elevator, complete	$440
1 root-washer, complete	320
1 Collas-stone separator	360
1 root-cutter; 8 boxes of knives, with 16 boxes extra for exchange	1,000
1 complete system of rotative diffusion (patented in Prague), patent rights included	9,000
Transmission of power, complete, about	960
Various vats for holding juice and milk of lime	225
Total approximate cost of apparatus, machinery, and accessories for system of rotary diffusion	12,305

PRODUCTION OF GAS.

1 metallic fixture for lime-kiln of 175 cubic feet capacity	680
1 gas-washer No. 1	215
1 blowing apparatus, with special motor, comprising 1 air-pump, 24½-inch cylinder and 16-inch stroke; 1 horizontal engine, No. 4, with 9-inch cylinder	1,796
1 tubing, complete, for conveying gas from furnace to washer, the blowers and saturating-pans, about	520

SATURATION.

1 horizontal pump for juice, for forcing juice to the first saturating-pan; 1 pump for forcing juice to second saturating pan	546
6 saturating-pans, complete, capacity 600 gallons each, about	2,760
6 floating regulators, No. 1, each $32	192
6 decanting vats, complete, about	566

SCUMS.

2 monte-jus of 330 gallons capacity, complete, each $210	420
2 Trincks filter-presses, each $336	672

FILTRATION.

4 bone-charcoal filters, 8 feet 3 inches high, 3 feet 11 inches diameter, each $188	752
1 boiler for reheating sirups, complete	336

EVAPORATION.

1 apparatus for evaporation in vacuo at a low temperature and with triple effect, complete	6,300
1 injection-condenser, No. 2	105
1 tubular reheater of about 390 square feet of heating-surface	568
1 mechanical system for horizontal air-pump, comprising 1 non-condensing engine, 1 double-effect air-pump, 14-inch cylinder and 20-inch stroke	1,790
1 system of pumps for juice and sirup for the service of the triple-effect pans.	546
1 receiver of exhaust steam, with safety-valve, forming escape valve, and pressure-gauge set at 4.4 pounds	250

BOILING.

1 boiler, complete	1,932
1 injecting-condenser, No. 1; 1 safety vase, No. 1	273
1 mechanical system for horizontal pump, No. 1, comprising 1 horizontal non-condensing engine, 1 double-effect air-pump, 11½-inch cylinder, 15¾-inch stroke	1,365

PURGING AND CLARIFYING.

1 machine for dividing the sugar	210
3 centrifugal filters (improved), each $290	870
1 non-condensing horizontal engine, 9-inch cylinder, 15¾-inch stroke	880
1 horizontal pump for molasses	290
1 transmission of power from engine to apparatus, about	650

BONE CHARCOAL.	
1 bone-black washer, with screw 13 feet long	$200
1 metallic portion of revivifying furnace, with 20 rectangular tubes	946
1 cylinder for washing bone-black with steam	210
Transmission of power in bone-black department, complete, about	252
WATER AND STEAM.	
1 mechanical system for pumps, variable; 2 semi-tubular boilers, with 1,498 square feet of heating surface, for setting in brick, with safety-valves, steam and pressure gauges, each $3,160	6,320
1 feed apparatus, with mechanically closed valves	580
1 direct steam conduit, placed above the boilers, about	420
1 return-water receiver	210
CRYSTALLIZATION.	
2 vats for first crystallization; 55,000 gallons of vats for the second and third crystallization, in rectangular vats of 6,600 gallons each, about	3,360
INCIDENTALS.	
Vats for sirups and lime, straight copper tubing, prepared copper tubing, cast-iron tubing, wrought-iron tubing, bronze stopcocks, iron stopcocks, sundries for construction, iron chimney for boilers, iron flanges and bolts; total about	7,300
Total approximate cost of apparatus, machinery, and accessories for extracting sugar from the juice	45,282

To these figures we may add about $25,000 for cost of packing and transportation of machinery, apparatus, and accessories, and erection of the buildings, &c.

The cost of extracting the sugar from beets will of course vary according to the facilities with which the works are provided. A writer in a late number of the *Journal des Fabricants de Sucre* gives the following estimate of cost of working in France. He remarks that it depends, 1st, upon the method of supplying the works, distance from supplies of coal, limestone, &c.; 2d, upon the relation existing between the capital employed in the work and the number of tons worked; 3d, upon the more or less improved machinery, apparatus, &c.

The estimate he makes is for a factory working by the diffusion process, or continuous presses for extracting the juice, having a capacity for 20,000 tons per annum, and representing a capital of $100,000. He then fixes the cost of manufacture per ton of roots as follows:

Beets		$4 00
Labor		80
Coal and coke		80
Incidentals		70
Repairs, &c		40
General expenses		50
Interest and redemption of capital		40
		7 60

He admits as the product:

Sugar, 121 pounds, at $5.454	$6 60	
Molasses, 66 pounds, at $0.91	60	
Pulp	50	
Scums from defecation	05	
		7 75
Profit per ton of roots worked		15

In this estimate he admits a yield of sugar of all grades of 5.5 per cent. the weight of the roots, and fixes the selling price of this sugar at 60 francs per 100 kilograms, or $5.454 per 100 pounds, but he considers that this price should, on account of the variations in market rates, be fixed at a lower figure, or 55 francs per 100 kilograms, and this would cause a loss of 30 cents per ton of roots worked.

He claims 5.5 per cent. as the average yield in the French factories, but it is evident that in very many it is higher than this. In case of higher yield, the cost of extraction, and the quantity of the bye products obtained would be about the same. Supposing the following gradation in the yield of sugar, and the selling price 55 francs, for the different yields of 6 per cent., 6.5 per cent., 7 per cent., 7.5 per cent., we should have, respectively, as profits per ton of roots worked, $0.15, $0.70, $1.25, $1.80.

These figures do not seem so favorable for the manufacturer as those I have been able to obtain directly from French manufacturers, through the kindness of Prof. B. Corenwinder, and M. E. Macarez, of Lille, and embodied in the following table, showing the cost of working, and the results obtained for a series of four years for the campaigns of 1873–'74 to 1877–'78, inclusive.

The table will explain itself.

Statement of expenses and receipts resulting from the transformation of one ton (2,200 pounds) of beets into raw sugar, Nos. 7–9 to No. 13, molasses at 40°, and other residues—the beets delivered at the works, the sugars delivered at station, molasses and other residues taken at the works.

[The figures of the tables give the averages of four factories, producing annually about 10,000 sacks (220 pounds each) of raw sugar, and working by means of new processes and machinery, double saturation of the juice, triple effect for the evaporation and boiling for crystallization (*cuite en grains*) of the sirups.]

DETAIL OF EXPENSES FOR ONE TON (2,200 POUNDS) OF BEETS.

Nomenclature of the principal general costs of manufacture.	1873–'74.	1874–'75.	1875–'76.	1876–'77.	1877–'78.
Purchase of beets	$4 00	$4 09	$4 07	$3 76	$4 11
Pay of laborers	76	74	77	71	72
Employés	18	17	16	18	18
Incidentals	02	02	02	02	02
Patent rights	08	07	07	08	08
Repair of machinery	41	39	43	47	33
Duty*					
Transportation	29	31	27	23	23
Oils, grease, &c	08	07	07	07	07
Animal charcoal	08	08	07	06	06
Insurance of workmen	02	02	01	01	01
Discounts, interests, commission	24	20	19	28	27
Limestone and coke	09	07	08	09	09
Coal	68	67	70	56	56
Woolen sacks, sugar sacks, &c	16	15	16	16	16
Total	7 09	7 05	7 07	6 68	6 89

* The duty on sugar, equivalent to 73.50 francs, $14.90 per 100 kilograms (220 pounds) of raw sugar, is not comprised in the figures noted here, neither in the expenses nor in the receipts. The public treasury accords four months of credit to the refiner, who is charged with the payment of this tax, and it is not therefore included in the price of sale.

DETAIL OF PRODUCTS FROM ONE TON (2,200 POUNDS) OF BEETS.

	1873–'74.			1874–'75.			1875–'76.		
	Quantity.	Price of sale.*	Total.	Quantity.	Price of sale.*	Total.	Quantity.	Price of sale.*	Total.
	Pounds			*Pounds*			*Pounds*		
Sugar	124.74	$11 04	$6 26	128.26	$11 78	$6 87	117.04	$10 11	$5 42
Molasses	79.20	2 78	1 00	74.80	2 26	77	80.96	1 52	56
Pulps	517.00	2 08	49	517.00	2 13	50	523.60	2 10	54
Scums of saturation	125.40	2 00	15	114.40	2 00	10	158.40	2 00	14
Manures and other matters	176.00	05	04	118.80	05	03	200.20	05	05
Total			7 94			8 27			6 71

	1876–'77.			1877–'78.		
	Quantity.	Price of sale.*	Total.	Quantity.	Price of sale.*	Total.
	Pounds			*Pounds*		
Sugar	97.68	$13 76	$6 11	133.65	$12 06	$7 33
Molasses	69.96	2 30	73	77.88	2 50	89
Pulps	572.00	2 30	60	585.20	2 24	59
Scums of carbonatation	129.80	2 00	12	151.80	2 00	14
Manures and other matters	220.00	05	05	220.00	05	05
Total			7 61			9 00

*Per quintal of 220 pounds.

RECAPITULATION.

[In this statement is not included the interest upon the joint capital, this capital being variable according as the works are old or new.]

	1873–'74.	1874–'75.	1875–'76.	1876–'77.	1877–'78.
Total value of products	$7 90	$8 27	$6 67	$7 61	$8 99
Total expenses	7 08	7 06	7 06	6 68	6 88
Difference in loss			39		
Difference in profits	82	1 22		93	2 12

The cost of working in the United States may vary somewhat from the figures we have given, but it is not probable that the variation will be very great; while the cost of labor is greater, fuel and other materials required are much cheaper, so that they counterbalance each other. We may, therefore, estimate the cost of extraction of sugar from the roots (the purchase price not considered) at about $3 per ton.

CHAPTER VIII.

TAXES, RATES OF—MODE OF COLLECTING—AMOUNTS COLLECTED.

The variations in the conditions of the laws of France fixing the rate of taxes on sugars, whether of home or foreign manufacture, are so numerous that it would be inadvisable to attempt to enter upon a detailed history of them here. Yet the present interest centering upon these laws is so great that it is believed a short sketch of them will not be devoid of interest and value.

As we have before shown, the manufacture of beet-root sugar did not attain industrial importance until 1812 to 1814, when, under the fostering care and liberal encouragement of Napoleon I, the schools for instruction of students in the methods of sugar extraction were inaugurated, and the first extensive factories were erected. But the industry did not recover from the reverses it suffered in consequence of the downfall of that great emperor, and the rise of the continental blockade until between 1820 to 1825, when it was encouraged by the duty which, for various reasons, it was found necessary to impose upon foreign and colonial sugars, and the invention of new and improved methods of extraction.

Immediately upon the accession of the new government, in 1814, foreign sugars were admitted on the same conditions as those of French manufacture, but it soon appeared that on account of the flood of English sugars that at once poured in, the French manufacture would suffer great injury if not complete destruction, and a discriminating tax of 20 francs ($4) was consequently imposed.

About the same time a general tariff on foreign sugars was established, in which a discrimination was made in favor of sugars made abroad in factories owned by French proprietors. The schedule per 100 kilograms was as follows:

	Francs.
Foreign raw sugars, other than white.	
By French ships:	
From India from French establishments	85
From India from foreign establishments	90
From elsewhere outside Europe	95
From warehouses	105
By foreign ships	110
Foreign white or clayed sugars (without distinction).	
By French ships:	
From India from French establishments	100
From India from foreign establishments	105
From elsewhere outside Europe	115
From warehouses	125
By foreign ships	130
French colonial sugars.	
By French ships:	
From India	60
From elsewhere outside Europe	70
From warehouses	75
By foreign ships	80

These rates were continued with slight variation until 1839 and 1840 relative to sugars from foreign sources, but in 1829 the production of indigenous sugar had become so extended and so prosperous that the government decided to make it subject to an internal revenue tax. This proposition did not, however, receive the sanction of the chambers, and it was not until 1837, when urged by colonial influences and complaints, that the tax was levied by a vote of the chambers and the co-operation of the government. This tax consisted of a fee of 50 francs ($10) for license to manufacture, and a special tax of 15 francs per 100 kilograms of raw sugar produced. The special tax was to be 10 francs from July 1, 1838, and 15 francs from July 1, 1839. The same law established grades of sugar depending upon grades of color.

According to Maumené the effect of this law was injurious to the manufacture in sections where fuel and labor were scarce and costly, and it was concentrated in the departments of the north of France, where these obstacles did not exist to the same extent, and the industry was crushed out in 17 of the 37 departments in which it had been established, and 63 of the 485 factories that had been in operation were closed, and the production fell from 49,000 to 22,000 tons. The law aroused bad feeling, and the suppression of the manufacture of beet-root sugar was suggested, and a proposition to this effect was even made by the government of Louis Phillippe to the chambers; but popular feeling was too powerful in its influence, and it was not made a law. In 1840 and 1843 the taxes upon sugars from foreign sources were established at 38.50 francs to 66.50 francs per 100 kilograms, according to origin and quality, for French colonial sugars, while for sugars from foreign ports it was made 65 to 75 for cargoes carried in French ships, and 85 for cargoes brought in foreign vessels, and consisting of raw sugars other than white; while for foreign white or clayed sugars, without distinction, it was from 80 to 95, according to origin, if brought in French ships, and 105 francs if brought in foreign vessels, without regard to origin. At the same time, the drawback upon exported refined sugars was established, with a premium gauged in such a way that 70 to 73 kilograms of refined sugar, according to form, corresponded with 100 kilograms of raw sugar imported. The second section of the same law established the rate of tax upon indigenous sugars, which varied according to the quality of the product, graded by the shade and form it was found to possess. The rates ranged from 25 francs per 100 kilograms to 36.10 francs, and were continued until 1843, when a law was enacted providing that from the 1st of August, 1844, and during four successive years, there should be an increase of 5 francs per year upon all sugars of the first type and upon inferior shades. This effected an ultimate increase to 45 to 58.50 francs per 100 kilograms, according to quality, and placed the indigenous sugars upon an equality as to taxes with the colonial sugars. But with the stimulus that had been given to the sugar industry by the various improvements that had been made in the methods of

manufacture enabled it to sustain this additional incubus upon it, and the production continued steadily to increase, as may be seen by reference to the statistical tables given in the previous pages of this report.

From this time on, the laws governing the taxes were submitted to frequent variations. In 1853 the method of assessing the tax upon the measurement of the volume and density of the juice worked was established, and was continued in spite of the dissatisfaction of manufacturers concerning it. By the law of 1846 it was determined that the minimum quantity of sugar that should be considered as the possible yield in the manufacture was 1,400 grams per hectoliter of juice (0.12 pounds per gallon), and that manufacturers should be compelled to pay tax on that amount. All excess was, at the same time, subject to tax. The different variations in the laws are too numerous and complicated, and would be of too little interest to be detailed here.

The laws of 1873 and 1876, which still continue in effect and govern the tariff on sugars, established the following rates relating to manufacture:

Rate of duty per 100 kilograms (220 pounds):

	Francs.*
Raw sugars from all sources, below No. 13	65.52
Raw sugars from all sources, from No. 13 to No. 20	68.64
Sugars similar to refined, white powders, above No. 20	70.20
Sugars refined in indigenous sugar factories and in the French colonies	73.32
Sugars extracted by barytic or other processes from exhausted molasses	26.00
Molasses not intended for distillation, and containing 50 per cent., or less, of sugar	19.34
Glucose in sirup or the concrete state	11.44

By an alternative provision in the law of January 6, 1876, depending upon the ratification of the agreement concerning sugars signed at Brussels August 11, 1875, the following classification was adopted:

A.—For payment of duty on consumption:

Below No. 13 of the series of types of Paris are classed sugars titrating less than 91°.

From No. 13 to No. 20, inclusive, sugars titrating from 91° to 98°, exclusively.

Among white powders, sugars titrating 98° or more.

B.—For the regulation of temporary admission:

The first class (15 to 18, inclusive) comprises sugars titrating from 92° to 98°, exclusively.

The second class (10 to 14, inclusive), sugars titrating 85° to 92°, exclusively.

The third class (7 to 9, inclusive), sugars titrating 76° to 85°, exclusively.

The fourth class (less than 7), sugars titrating less than 76°.

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* 1 franc = $0.1945.

The agreement of 1864 established the following yields of crystallizable sugar for the different numbers:

	Per cent.
Nos. 14 to 18	94
Nos. 10 to 13	98
Nos. 7 to 9	80
Below No. 7	67

The following is the schedule of the general rates of import duties per 100 kilograms:

	Francs.
Below No. 13, imported direct from countries outside of Europe	65.52
Nos. 13 to 20, imported direct from countries outside of Europe	68.64
Below No. 13, imported from European warehouses	68.64
Nos. 13 to 20, imported from European warehouses	71.76
White powders, above No. 20, from French colonies	70.20
White powders, from foreign countries	Prohibited.
Refined, from French sugar-making colonies	73.32
Refined, from other possessions	Prohibited.
Refined, from foreign countries	Prohibited.
Raw-beet sugars from Belgium, extra tax	2.00
Raw-beet sugars from Germany or other countries with which treaties of commerce have been concluded, Austria excepted	2.00
Raw-beet sugars from Austria	francs 3.60 plus 4 per cent.
Sugars imported directly by sea from countries outside Europe may be admitted for refining for exportation.	
Molasses for distillation from French colonies	Exempt.
Molasses for distillation from foreign countries	3.12
Molasses for all other purposes, containing 50 per cent. or less of sugar	25.42
Molasses for all other purposes, containing more than 50 per cent. of sugar	68.64

Articles 5 and 6 of the law of 1875 provide that sugars imported to France for refining shall be subject to a tax of 73.50 francs per 100 kilograms of sugar that it is presumed will be obtained by the refining process. "At the time of payment of the duties a warranty-bond will be executed at the desire of the importer, good for two or four months."

Article 8 provides that at the exportation of refined sugars the customs service shall deliver a certificate of export, stating the nature, weight, and saccharine richness. Certificates of export not having been dated more than two months, shall be received as compensation, either in payment of duties on sugars or of the warranty-bonds above mentioned, for a sum equivalent to the duty that would have been paid upon them had they been delivered for consumption.

A decree of August 8, 1878, provides in general for a drawback upon all articles of confectionery, comfits, preserves, &c., equal to the tax that would be required upon the sugar they contain.

The method of collecting the taxes upon sugar in France is the same in principle and similar in practice as that in use in this country for collecting internal revenue on spirits. An officer of the government is stationed at each factory, and is charged with making an examination and keeping a record of the material worked, as well as the products obtained. The latter must have a certain relation to the former, *i. e.*,

as stated before, a certain quantity of juice having a given density must yield a given quantity of sugar, and the manufacturer is taxed for this minimum yield determined by the examination of the juices. All products of the factory are taken in charge by the officer and stored in a warehouse, the key of which is in his possession, and the sugar is kept here until disposed of for refining or for other purposes. The tax, 73.50 francs per 100 kilograms, is finally levied upon the quantity he takes in charge.

The amounts of taxes realized by the government of France on sugars from all sources during the years 1877 and 1878 were as follows:

Kinds of sugars.	1878.	1877.
Import duty on colonial sugars	$7,540,800	$6,768,760
Import duty on foreign sugars	6,886,000	8,642,000
Duty on manufacture of indigenous sugars	22,088,400	17,035,600
Total	36,515,200	32,446,360

CHAPTER IX.

CONCLUSION—IMPORTANCE OF SUGAR-BEET CULTURE.

In France the universal importance of the influence of the culture of the sugar-beet was rather slow in being acknowledged by those accustomed to write on the subject, but once it became thoroughly manifest, it was earnestly accepted, and the introduction of the crop in the systems of rotation rapidly took hold in all sections in which it could be made successful. The value of the culture in the amelioration of the soil was recognized by Dubrunfaut as early as 1825, when he said:

> The beet as a biennial plant enters readily into rotation with annual plants and with those considered as exhausting. It precedes wheat with great advantage and prepares the soil in a marvellous manner for crops of cereals.

In 1853, Prince Napoleon Louis Bonaparte, after a study of the subject, said:

> The beet requiring frequent hand-hoeing and considerable fertilizing improves the soil. It is a fact that wheat sown after a crop of beets produces 10 per cent. more than after any other culture. In fact, everywhere that the beet is grown the selling value of the land has considerably increased, the wages of workmen have followed the same ascending progression, and the general welfare has improved in a wonderful manner.

Behic, reporting to the council of state on a draught of a law concerning sugars in 1850, said:

> Metropolitan agriculture and industry are interested in the production of sugar from beets. By the aid of this industry cattle-raising is encouraged, rotations favored, the mass of manures augmented in countries where this kind of work has been established; the culture of oleaginous seeds, hemp and flax, being crushed out by the beet, has all tended to enrich localities which had previously known only the culture of vulgar plants.

These sayings are all quoted by M. Mariage in a report upon the industry in the arrondissement of Valenciennes, made on the occasion of the Universal Exposition of 1867.

Further on in the same report, M. Mariage shows that in the arrondissement of Valenciennes, between 1854 and 1866, there was an increase of 103 in the number of oxen and bulls, 437 cows, 2,580 young cattle, and 3,144 goats. This rate of increase in the number of cattle is not found in other portions of France consequent upon the introduction of the beet-sugar industry, but it appears to be generally accepted among the agriculturists of the north of France that while the numbers of cattle have not increased to any considerable extent there has been a marked increase in the average weight of beef-cattle, amounting to from 50 to 75 per cent., and this increase is referred to the extensive use of beet-root pulp for food. By reference to the table given in the chapter treating of the statistics, we find that this industry, confined to a comparatively small area in France, gives employment to over 50,000 individuals during the winter season, and all these people are left free during the summer season to assist in the cultivation of the fields, and the large majority find employment there. They not only manipulate the raw product of the farm but they are producers as well. In this particular this industry is one of the greatest boons to the laboring classes that can well be imagined.

The amelioration of the soil by beet-root culture has already been referred to. In this industry nothing should be lost to the farm, though it cannot be said that this is always carried out. The marketable constituent of the crop, the sugar, takes nothing from the soil in its formation. All its constituents are derived from other sources, atmospheric, &c. Much of the mineral matter of the crop is returned to the farm in the refuse of the factory, though a large proportion is lost in the molasses sent to the distillery, the residues of which are in most cases worked for the recovery of the alkaline salts to be used for other industrial purposes. It may, however, be justly said that in the culture of this crop, besides the improvement effected in the physical condition of the soil, its chemical character suffers less from this than from other crops.

The statement of Prince Louis Napoleon has found confirmation in the results universally obtained in culture of wheat and other cereals; for the cereal crops cultivated have increased to a very marked extent both in acreage grown, the yield per acre, and the weight of a given volume of the grain. As a consequence of the beneficial influences of beet-root culture on the land, we find that its advance into any section is soon followed by an increase in the value of property, and M. Macarez, in a short sketch lately presented of the history and importance of the culture in the arrondissement of Cambrai, states that in 1835 land cultivated in beets was worth $120 per acre, and that in 1875 the same land was worth $280 to $325 per acre, and relations of a very similar character prevail in all the departments of France where the culture has become firmly established.

Another advantage that may be claimed for beet-root culture, and one that would have great importance in the United States, is the utilization of the land annually left open to fallow, and this would effect a great saving, and be a fruitful annual source of profit to cultivators. In this country, the ground, after previous culture of Indian corn, would be in excellent condition for the beet crop, after having been broken up in the fall, and could, after beets, be planted in the subsequent spring in oats or barley, and these in turn, after application of stable manures, may be followed by wheat. M. Mariage, speaking of the disappearance of fallow in the arrondissement of Valenciennes says:

> It has radically extirpated fallow, which at the beginning of the century was represented by 11,362 acres; in 1840 by 9,875, and in 1857 by 103. There does not now remain a trace.

In the introduction of the culture of the beet and the manufacture of sugar therefrom the enterprise will not have the same advantages in its favor, as to the value of the ultimate product, as the Europeans had at the birth of the industry on the other side of the Atlantic. In the beginning of the work their sugar was worth 125 to 128 francs per 100 kilograms ($11.36 per cwt.), and it was several years before it fell to 90 to 100 francs; but now that the price has fallen to 53 to 58 francs, the manufacturers find themselves in the unpleasant predicament of being unable, with the apparatus they have in their works, to extract the sugar from beets of the average production, which are generally of low quality, at a cost sufficiently low to compete with products from external sources. However, in the United States we may have the advantage of the experience gained in the European works, so that, instead of having to begin upon a raw product of low quality and crude methods of culture, fertilizing, and manufacture, we may start with those varieties of seed and those methods of culture and manufacture which have been found by long practice to give the highest return for the capital and labor employed.

But the greatest obstacle to the ready introduction of this valuable industry into sections before unknown to it, and where all the conditions of soil and climate are favorable to it, will be found in the difficulty of securing at once concerted action on the part of the farmers to produce each year a quantity sufficient to be economically worked for sugar on the one hand, and the capital necessary for the erection and maintenance of the buildings, machinery, and apparatus required for extracting the sugar, on the other hand. A limited number of farmers may be found, in almost every section of the United States in which beets could be grown with good results as to quantitative yield, who would be willing and even anxious to undertake the culture if a regular market could be found for their crops. As we have seen in an earlier portion of this work, the product of at least from 500 to 800 acres is required for economical and profitable work in the manufacture of sugar from the beet by the usual European methods, and few proprietors could be found east

of the Mississippi who would care to undertake singly the cultivation of that area, or who would even have the ability to do so.

The importance of sugar production in the United States makes it worthy of extended encouragement not only by the State governments, but by the national government as well. Beets are produced in France with great profit for the production of alcohol, and the residues from this branch of manufacture have been found almost as valuable for cattle food as those from the sugar factory, and by many agriculturists are even preferred.* The apparatus required for converting the sugar of a crop into alcohol is much less costly and extensive than that required in the extraction of sugar. But in this country no special apparatus nor the erection of special works would be necessary on account of the numerous distilleries already distributed throughout the land for the manipulation of cereals. The same apparatus, with very slight additions, could be employed for the manipulation of beets for the production of spirits, and they could be worked in any quantity, however limited, instead of grain, and when the stock of roots is exhausted, the distiller may then return to his grain. But just here a serious difficulty arises. Beets could not, at present at least, be produced at a cost sufficiently low to compete with cereals in this branch of manufacture, and to offset this disadvantage and to induce the culture of the sugar beet throughout the country, I would suggest that spirits manufactured from sugar beets† be made exempt from tax for a term of years to be definitely fixed as to duration, or during this time be subjected to a tax sufficiently low to enable the roots to successfully compete with the cereals, and to cause them to be sought after to some extent in preference to them. The demand thus created would open a market at once, and the culture would, in consequence, be engaged in without delay, at first upon a small scale very naturally, but it would also very naturally become more and more extended until limited by the bounds of the region of successful culture, and the latter would at the same time be determined. The difficulty of entering thus into a new enterprise on a large scale, without previous experience, would be obviated, and the American farmer would not be slow to realize the benefits, besides the immediate profit he would secure from his crop, to be found in the improvement of his soils, the increase in the quantity and value of his grain crops, or of his beef or dairy cattle. At the end of the term of years proposed for the reduction of the tax on spirits manufactured from the sugar beet, when the tax would again be exacted and his market thus destroyed, unwilling to lose the subsidiary advantages he has recognized as resulting from his new culture, and seeking new markets for the crop that will have proven

* This mode of disposing of the crop has also the merit of returning to the farm not only all the nitrogenous compounds in a suitable condition for feeding, but it saves all the mineral matters as well, none being lost in molasses.

†In order to insure the cultivation of rich races, a provision could be made that no roots be admitted for manufacture under such regulation, except those the juice of which should contain over 10 per cent. of sugar, and have a density not below 1.050.

so valuable to him, he will seek new markets, and he will be ready to supply to the factories which may then be established the raw product necessary to successful and economic work. The extent of cultivation in this way induced would seem to leave no question as to the possibilities of securing all the supplies that an average manufactory would require, and the difficulty of making contracts for such supplies would be materially reduced if not entirely abolished.

The loss the government might sustain by the temporary reduction in the revenue from spirits might be subsequently compensated for by establishing a tax upon the sugar produced, so that if we consider that if from the introduction of this industry sufficient sugar may be produced to supply our home demand, it would not only become the cause of retaining annually in this country about one hundred millions of dollars, and a source of employment to over 100,000 laborers, but might, at the same time, become as fruitful a source of revenue to the government in the future as spirits and tobacco have been in the past and are to-day.

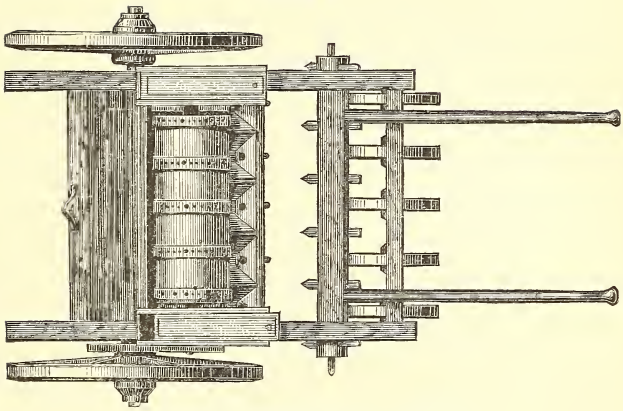
APPENDIX A.

The following cuts are intended to show some of the more essential apparatus and machinery used abroad in the production of beet-root sugar. At the outset of the preparation of the manuscript of this report it was determined that its complete illustration would be impracticable, but after the completion of those chapters relating to culture and manufacture the frequent demand for information concerning the forms of apparatus and machinery employed seemed to render this appendix necessary. We have, therefore, brought together the following series of illustrations of the later and more improved forms, most of which have been mentioned in the text of the report. In order to make them better understood each one is accompanied by a short legend, with letters of reference to the different parts where this has appeared necessary. This legend is principally intended for those not thoroughly familiar with mechanical construction and designs. Many of the details which, in the illustrations, will be readily understood by machinists, but which are not needed for a general comprehension of the principles involved in the apparatus represented, are, therefore, omitted.

We have also attached to each a reference to the author or publication from which it was taken. These are: Maumené, *Traité Theorique et Pratique de la Fabrication du Sucre;* Basset, *Guide Pratique du Fabricant de Sucre;* Stammer, *Traité Theorique et Pratique de la Fabrication du Sucre;* Walkhoff, *Traité Complet de Fabrication et Raffinage du Sucre de Bettraves* (translated from the German by Merijot and Gay-Lussac); *Journal des Fabricants de Sucre*; *La Sucrerie digène.*

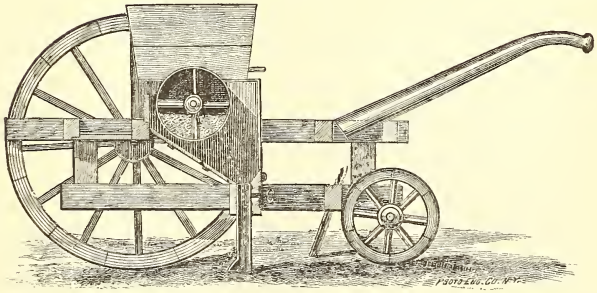
PLATE I.

FIG. 1.



FRENCH SEED DRILL.—(BASSET.)
Ancient form; horizontal view.

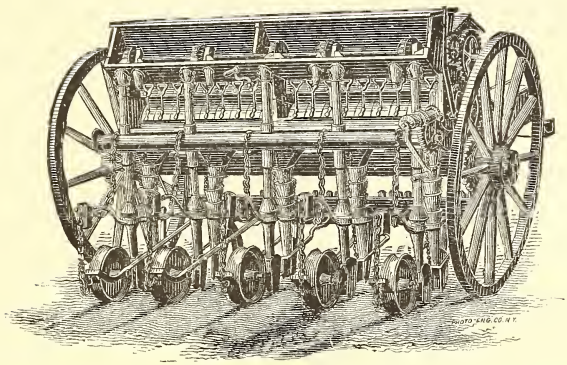
FIG. 2.



FRENCH SEED DRILL.—(BASSET.)
Ancient form; vertical section.

PLATE II.

FIG. 3.

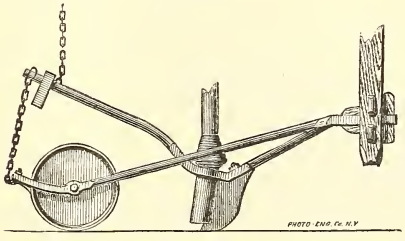


COMBINED BEET-SEED AND FERTILIZER DRILL FOR FLAT CULTURE.

JAS. SMYTH & SONS, PEASENHALL, SUFFOLK, ENGLAND.

The machine has a range of five hoes 18 inches apart, but the machines vary in number and interval of the hoes, and in price.—(KNIGHT.)

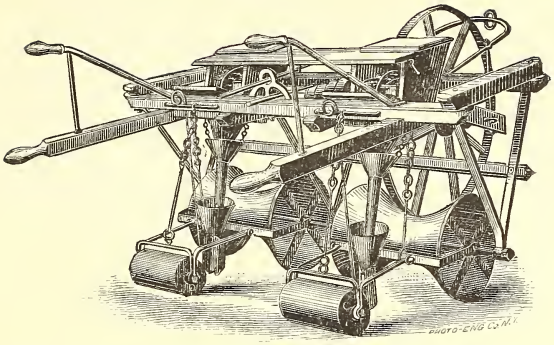
FIG. 4.



DETAIL OF HOE AND COVERING WHEEL.

PLATE III.

FIG. 5.

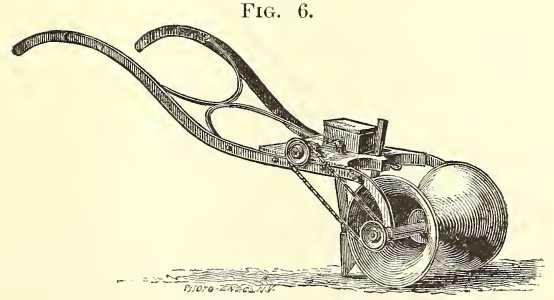


DRILL FOR TURNIPS AND BEETS IN RIDGE CULTURE.

CORBETT & PEELE, SHREWSBURY, ENGLAND.

The machine drills two parallel rows. On each side of the machine is a concave ridging roller, a hollow share which receives the seed from the box above, and an iron roller for covering the seed. The seed wheels are of the usual English form, having little hemispherical cups to dip up the seed and drop it into hoppers, from which conductors lead to the hollow shares which open the furrows.—(KNIGHT.)

FIG. 6.



FRENCH HAND DRILL.

In this form the seed is delivered to the conductor by a brush.—(KNIGHT.)

FIG. 7.

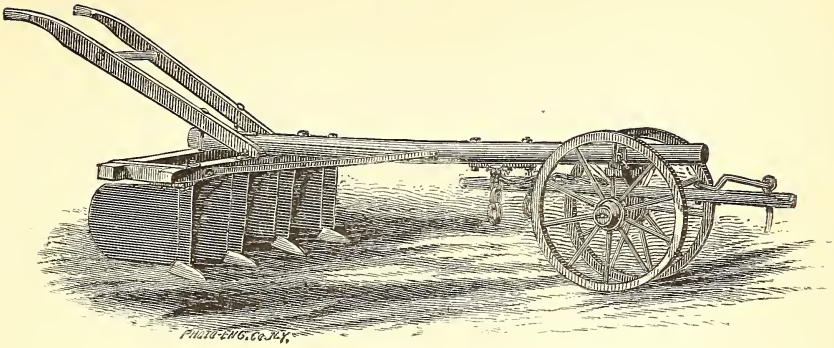


FIG. 8.

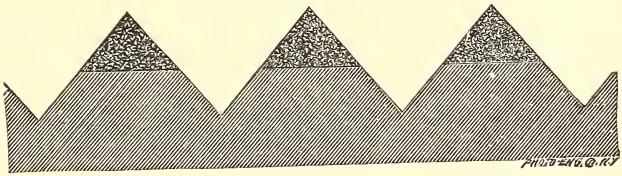
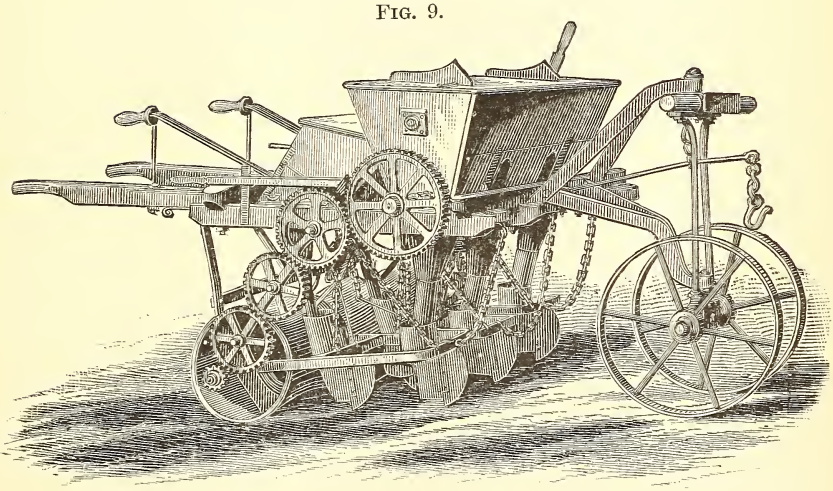


FIG. 9.



BERTEL'S RIDGER, DRILL, AND CULTIVATOR.—(JOURNAL DES FABRICANTS DE SUCRE.

Fig. 7. Ridger.
Fig. 8. Ridges before sowing.
Fig. 9. Seed Drill and Fertilizer Distributer.

FIG. 10.

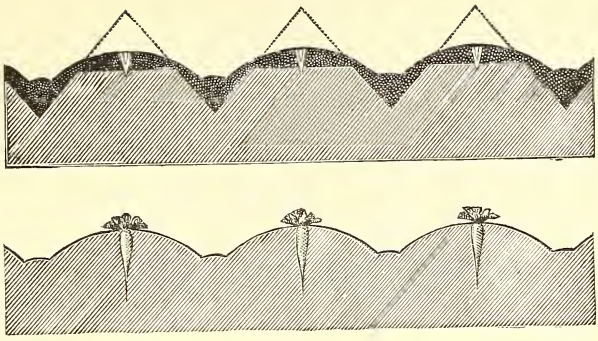
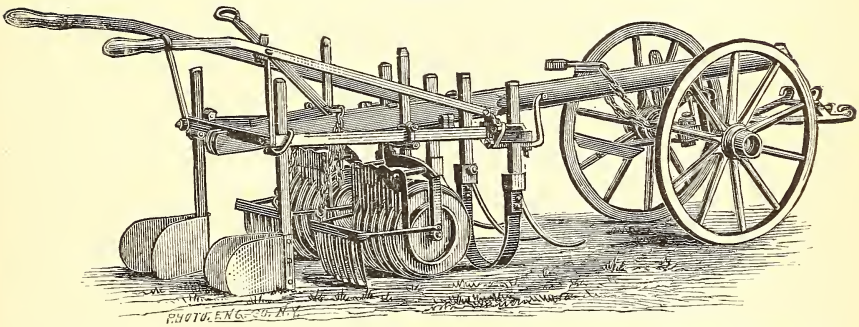


FIG. 11.



BERTEL'S RIDGER, DRILL, AND CULTIVATOR.—(JOURNAL DES FABRICANTS DE SUCRE.)

Fig. 10. Ridges after passage of drill.
Fig. 11. Cultivator for working between rows or ridges.
Fig. 12. Scarifiers and rollers for flat culture.
Fig. 13. Leader to Cultivator.

FIG. 12.

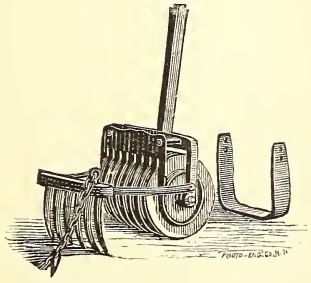


FIG. 13.

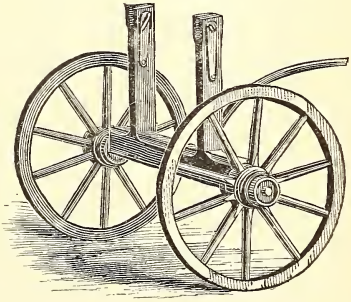
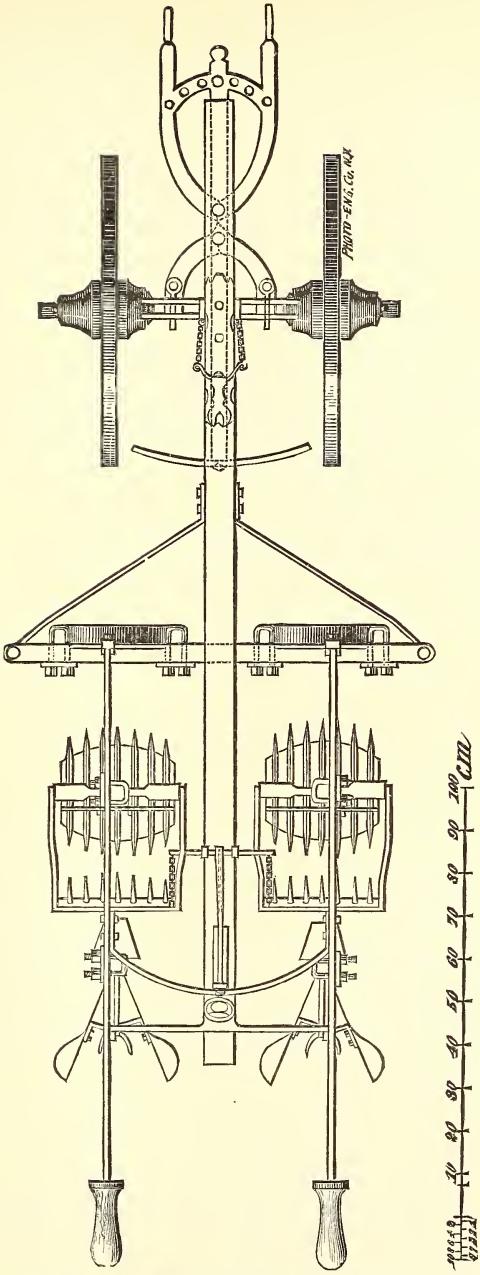


PLATE VI.

FIG. 14.



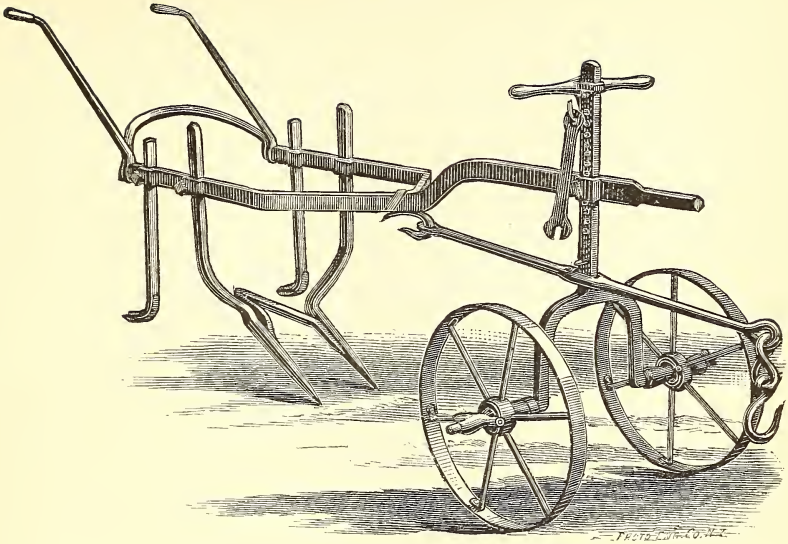
BERTEL'S RIDGER, DRILL, AND CULTIVATOR.—(JOURNAL DES FABRICANTS DE SUCRE.

Horizontal view of cultivator.

NOTE.—100 *cm* = 39.3 inches.

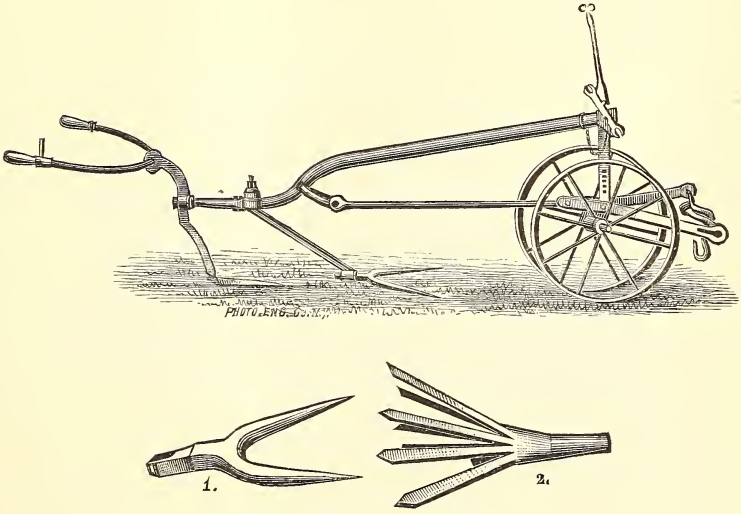
PLATE VII.

FIG. 15.



FRENCH ROOT DIGGER.—(JOURNAL DES FABRICANTS DE SUCRE.)
Eveloy's invention.

FIG. 16.

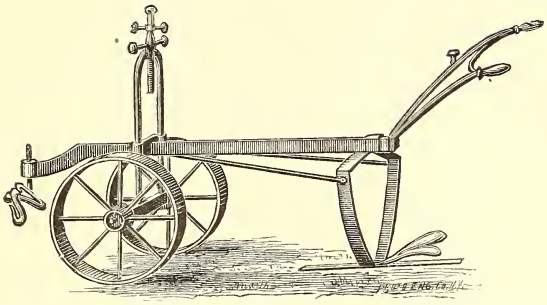


COMBINED BEET AND POTATO DIGGER.
DELHAIE-TAILLEUR & BAJAC, LIANCOURT (OISE) FRANCE.

In this machine adjustable pieces, which are shown separately, may be substituted for each other as desired; 1 for beets and 2 for potatoes.—(KNIGHT.)

PLATE VIII.

FIG. 17.

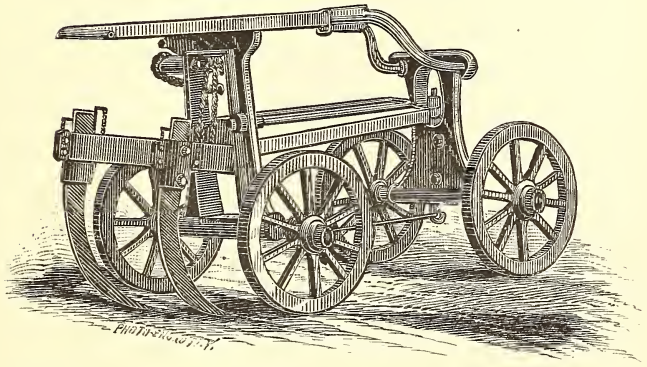


BEET DIGGER.

DELHAIE-TAILLEUR & BAJAC.

With this instrument the tap root of the beet is cut off, and the beet raised from the ground.—(KNIGHT.)

FIG. 18.



GERMAN ROOT DIGGER.—(WAHLKOFF.)

PLATE IX.

FIG. 19.

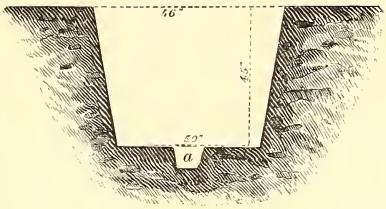


FIG. 20.

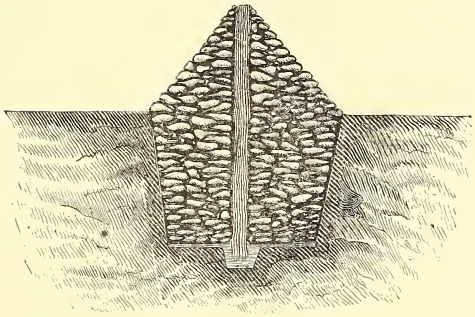
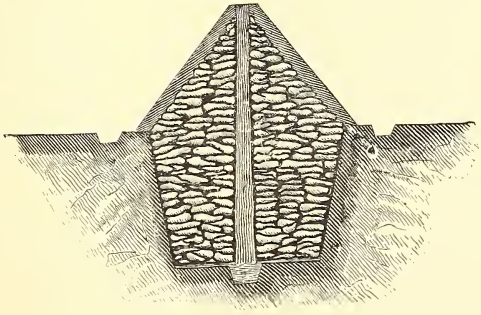


FIG 21.



PRESERVING TRENCH.—(BASSET).

Fig. 19. Trench open; *a*, drain trench.
Fig. 20. Trench filled, with ventilating shaft arranged.
Fig. 21. Trench filled and covered.

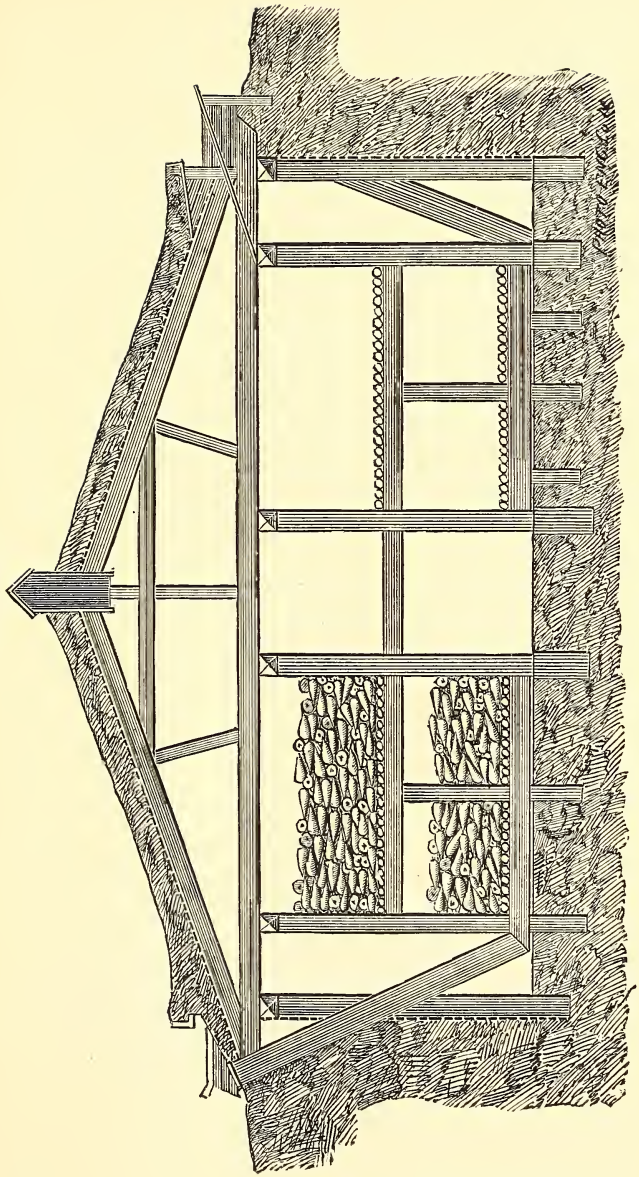
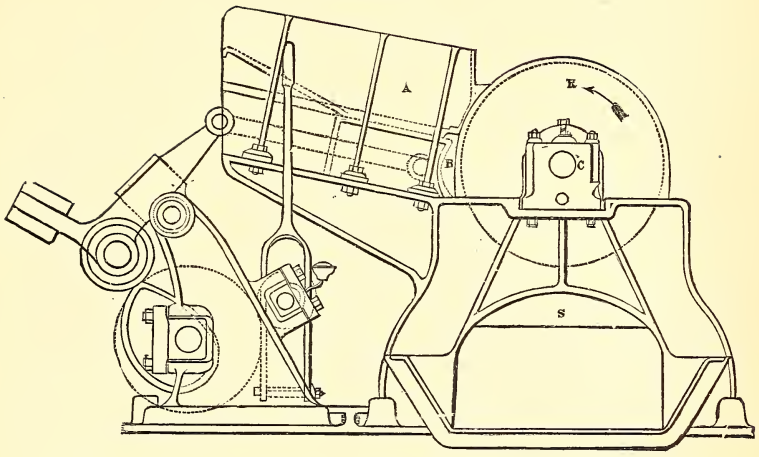


FIG. 22.

PRESERVING CELLAR.—(WAHLKOFF.)
Russian plan, vertical section.

PLATE XI.

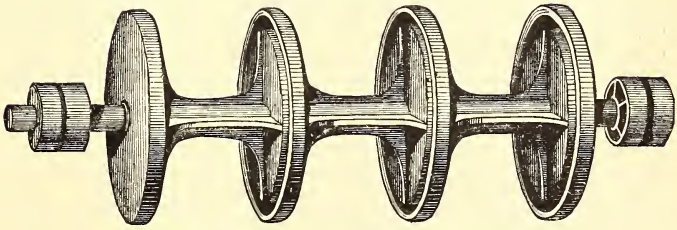
FIG. 23.



LAMPADIUS RASP.—(MAUMENÉ.)

A. Hopper for roots.
B. Plunger to force roots against cylindrical rasp.
C. Turning in direction of arrow R.
S. Trough to receive pulp.

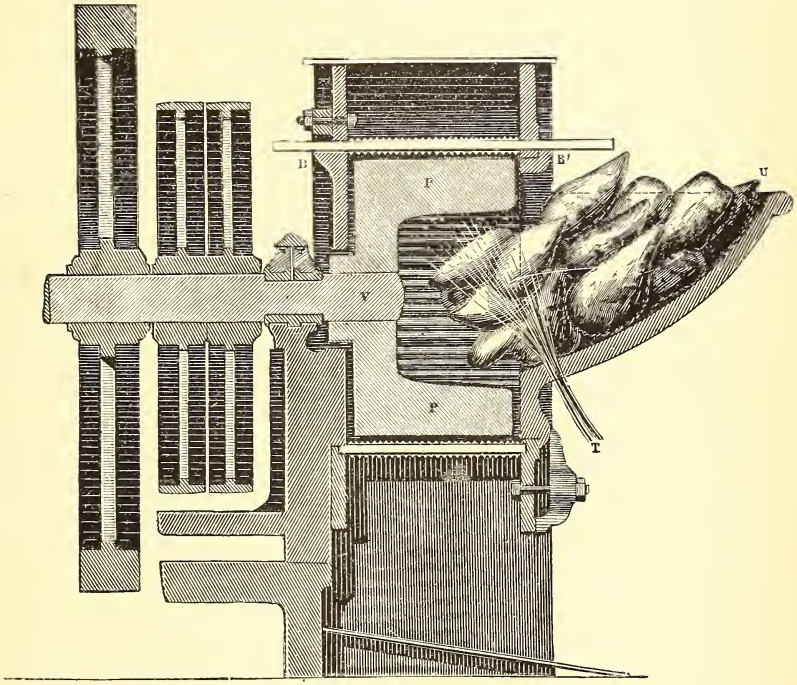
FIG. 24.



FRAME FOR CYLINDRICAL RASP.—(MAUMENÉ.)

PLATE XII.

FIG. 25.



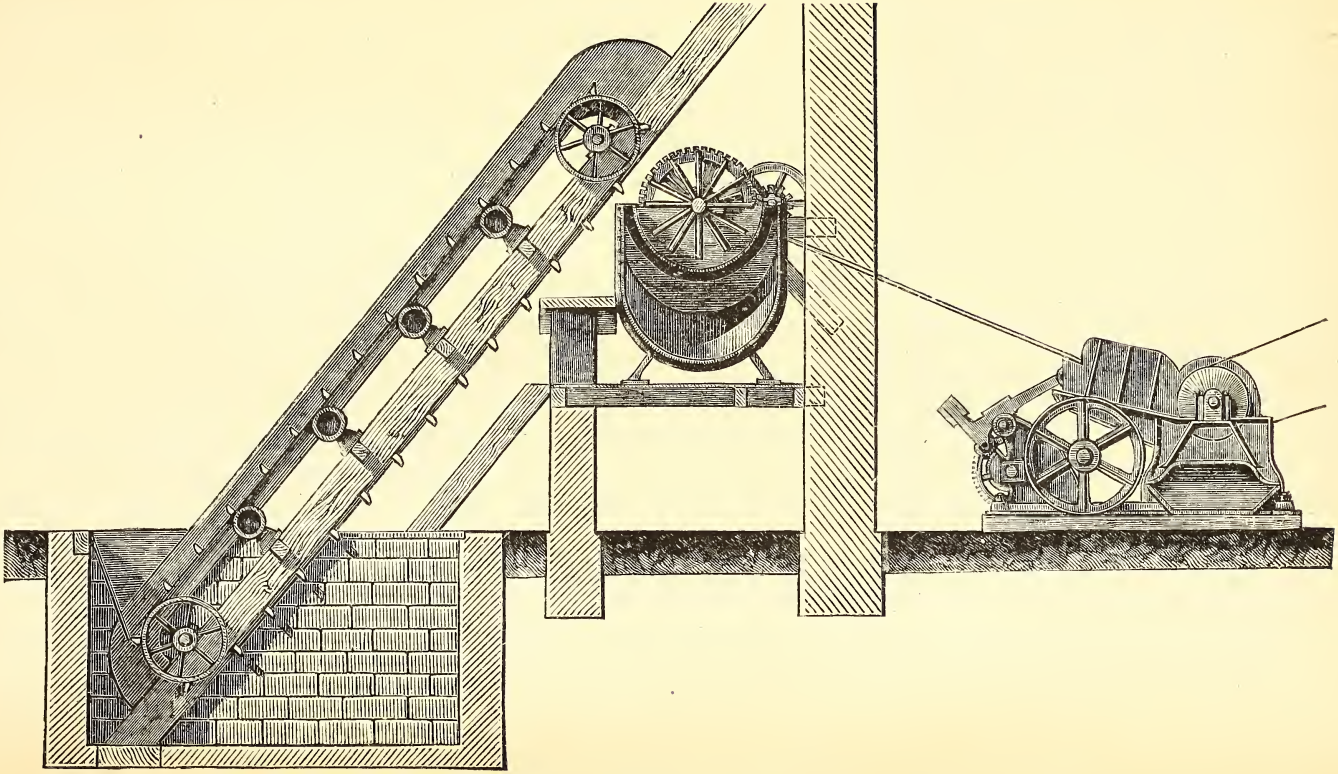
CHAMPONNOIS RASP.—(MAUMENÉ.)

M. Hopper for roots.

P, P′. Heavy cast-iron arms attached to axle V, and which, by rapid revolution, force the roots against rasps held in frame B B′.

T. Pipe to convey jet of water to interior of rasp.

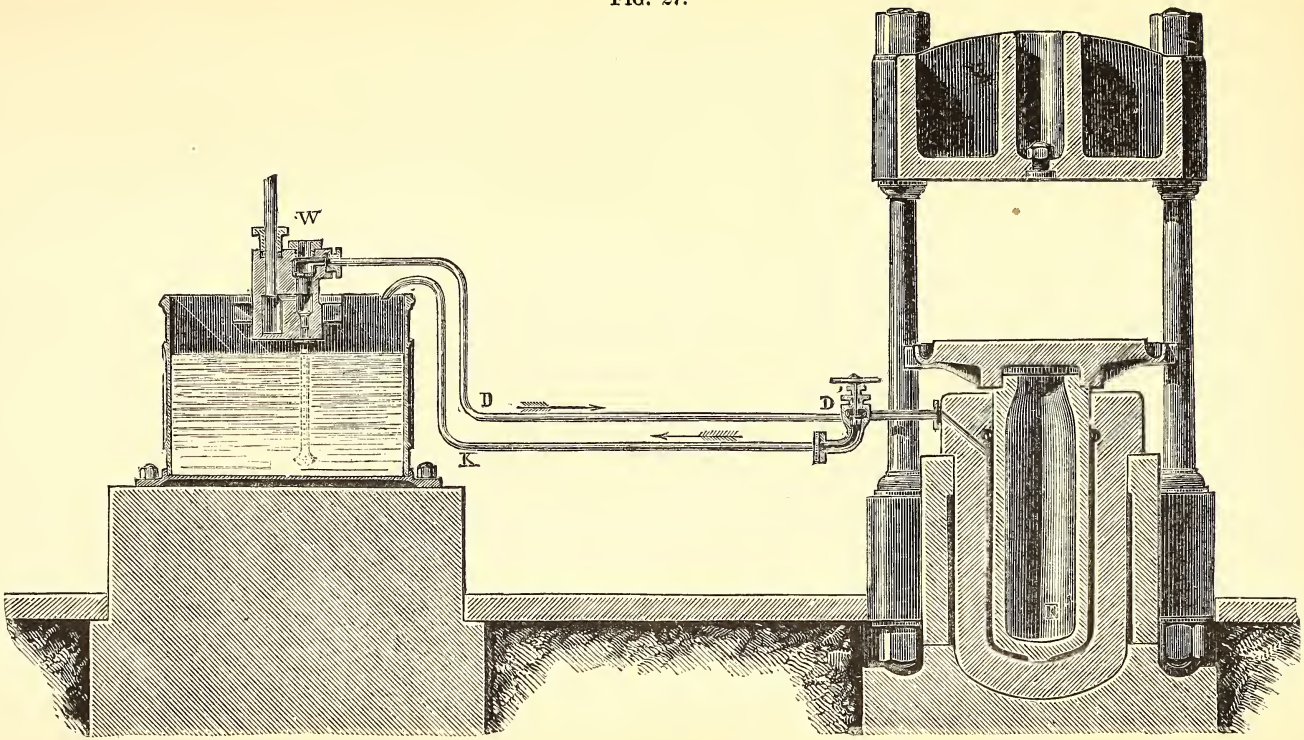
Fig. 25.



COMBINATION OF ROOT ELEVATOR, WASHER, STONE SEPARATOR, AND RASP.—(Stammer.)

PLATE XIII.

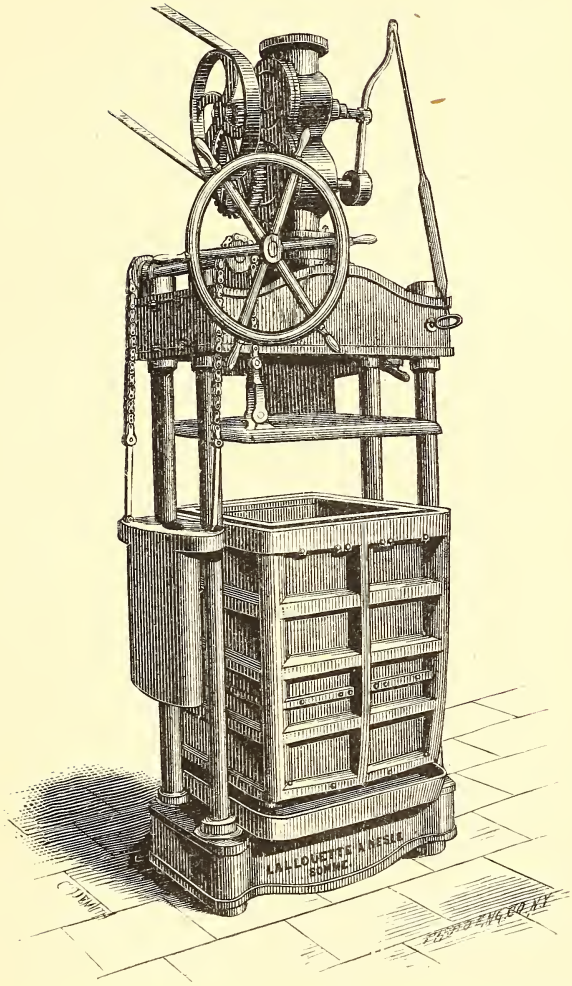
FIG. 27.



ORDINARY HYDRAULIC PRESS.—(MAUMENÉ.)

W. Pump. D. Pipe for conduit of water to press cylinder. K. Return water-pipe. K′. Press piston.

FIG. 28.

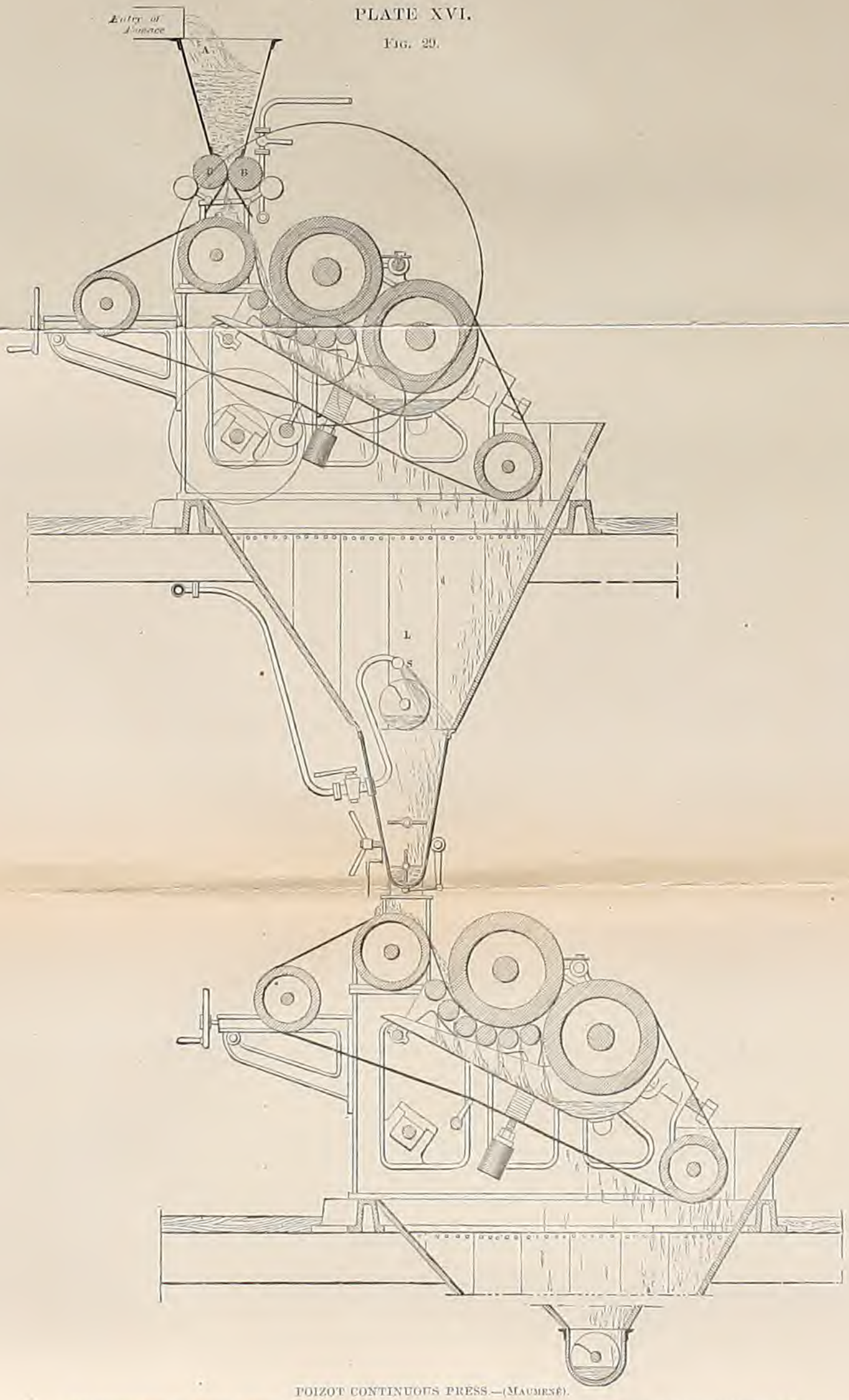


LALOUETTE IMPROVED HYDRAULIC PRESS.—(JOURNAL DES FABRICANTS DE SUCRE.)

It is claimed for this press, that it increases the yield in sugar, suppresses three-fifths the labor required with ordinary hydraulic presses, and leaves but 17 to 18 per cent. of pulp.

PLATE XVI.

FIG. 29.

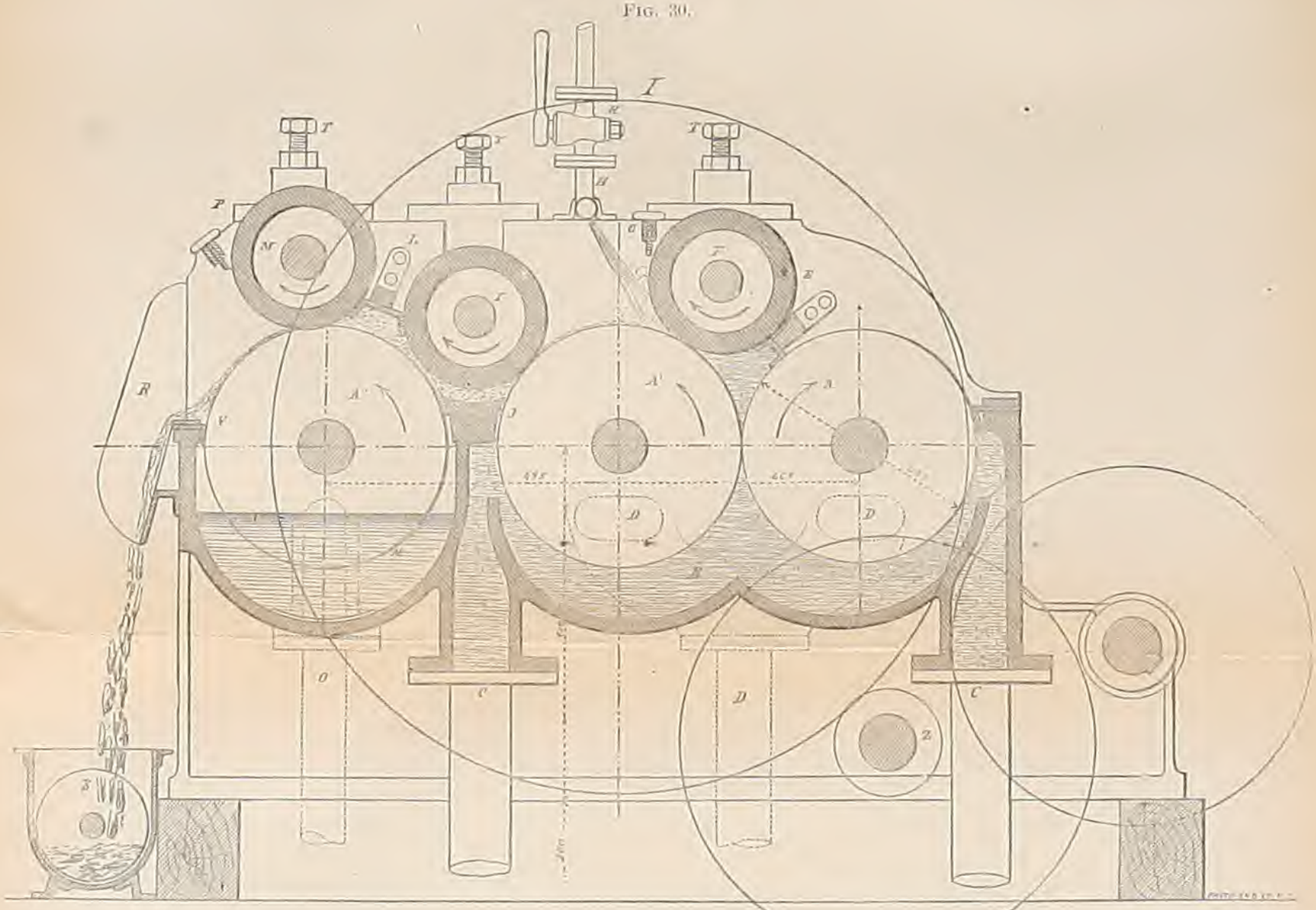


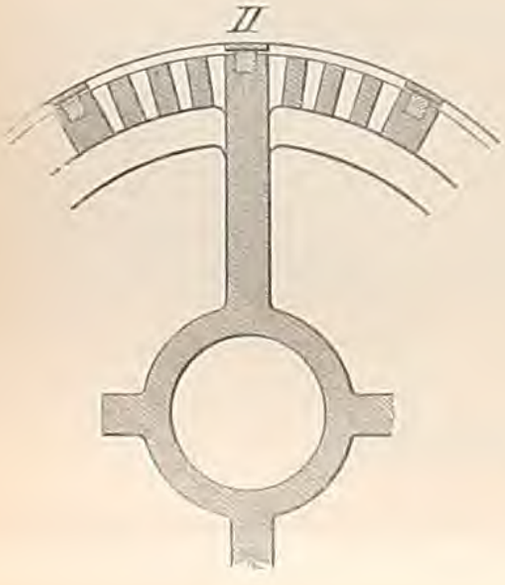
POIZOT CONTINUOUS PRESS.—(MAUMENÉ).

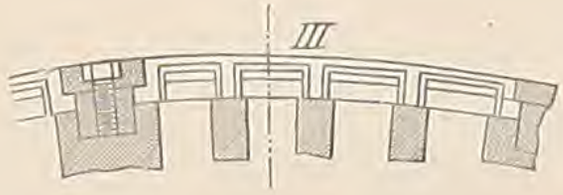
The pomace from the hopper A passes between the feed rollers B, and falls upon an endless belt, by which it is carried between the several rollers, and thus submitted to constantly increasing pressure. From the first belt the pulp falls into the hopper L, where it is mixed with water from the jet S, and from which it falls upon and is carried through a second press arranged below.

PLATE XVII.

FIG. 30.



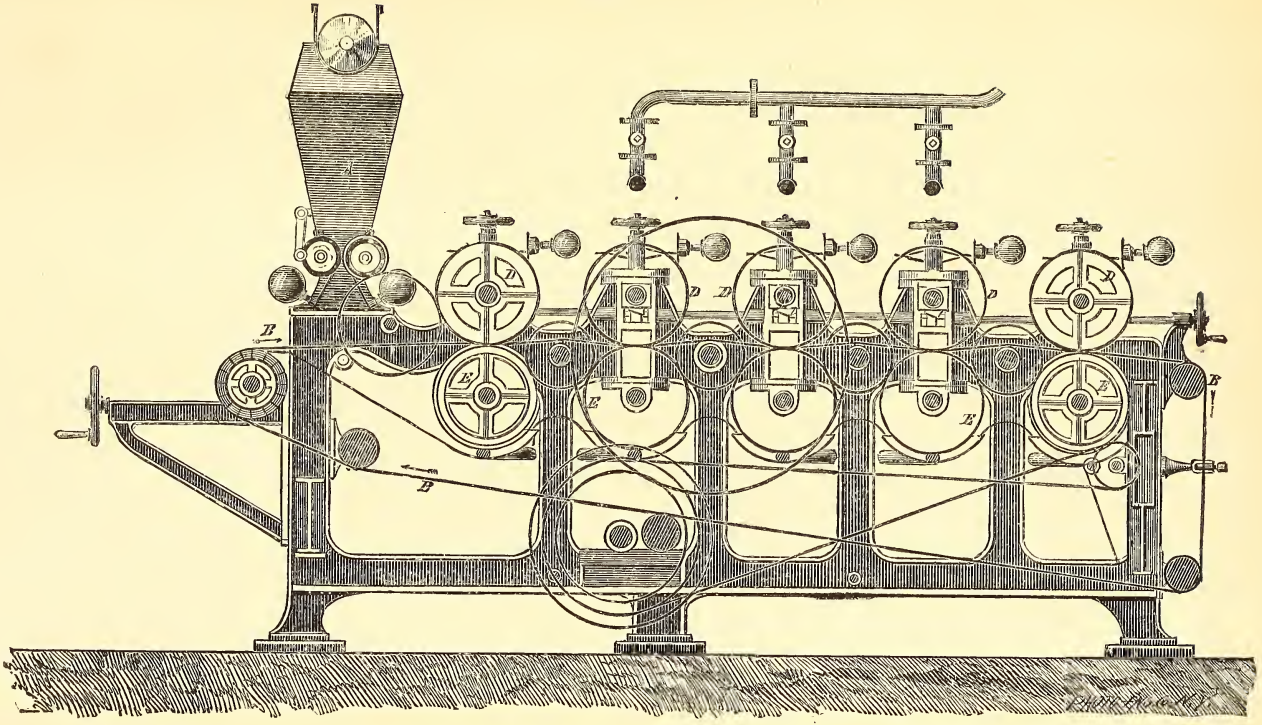




LEBÉE CONTINUOUS PRESS.—(MAUMENÉ.)

I. Vertical section of press. The pomace is forced by means of a strong pump through the pipes C C' into the chamber B, from which it passes between the cylinders A A', provided with filtering surfaces, then under the solid cylinder E' rolling upon A', after which it is treated by a jet of water from H. It then passes beneath the solid rollers I and M, working against the filtering-cylinders A' and A''. The expressed juice flows away through the pipes D and O. *II* represent a vertical section of the filtering-cylinder, and *III* section of the filtering-plates.

FIG. 31.



MANULL AND SOCIN CONTINUOUS PRESS.—(MAUMENÉ.)

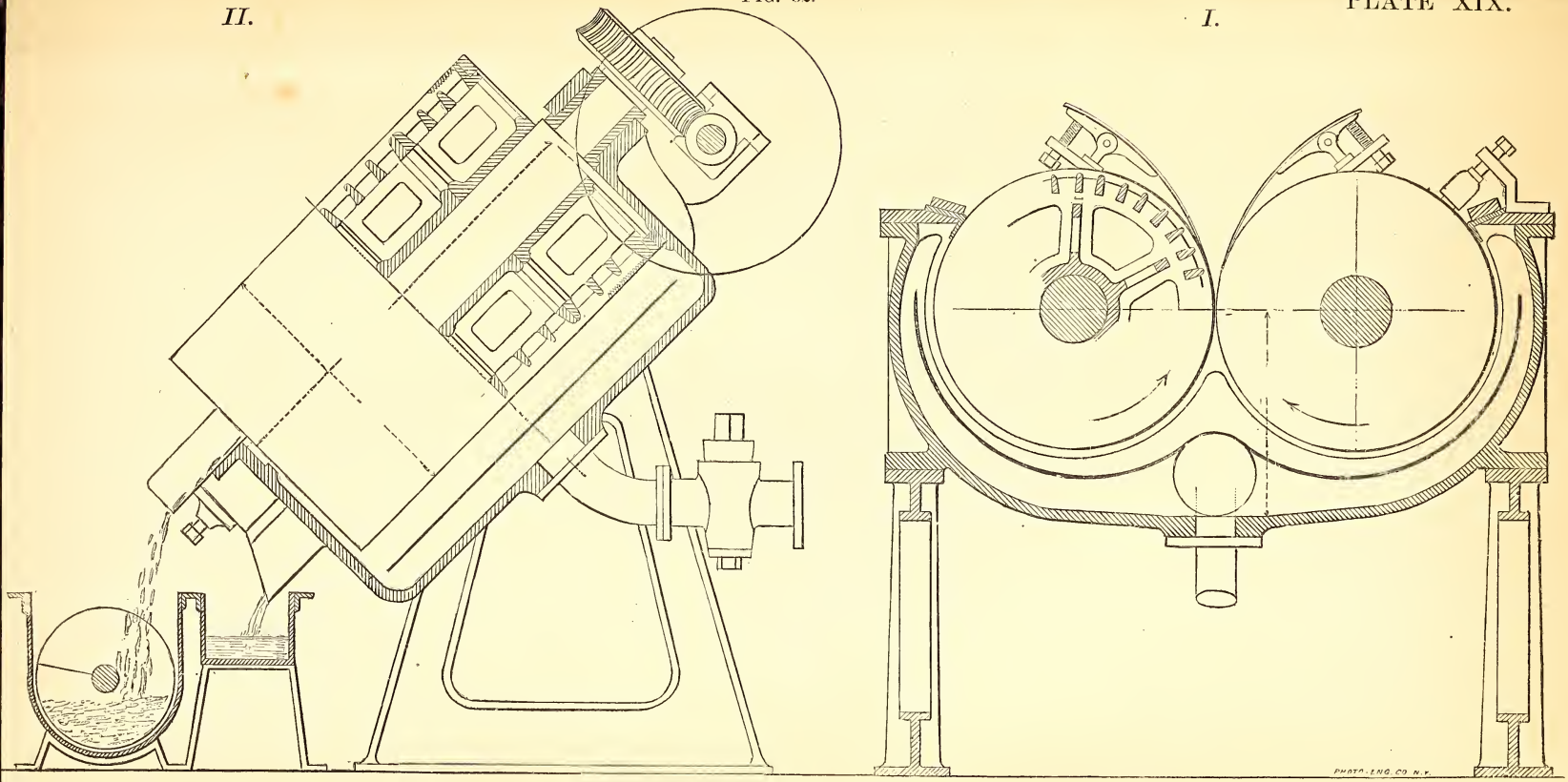
The pomace from A falls between the feed-rollers upon the endless belt B, and is carried between the solid rollers D D D D D and E E E E E. The pressure exerted by the rollers is adjusted by means of screws and springs attached to the journals.

PLATE XVIII.

FIG. 32.

II.

I.

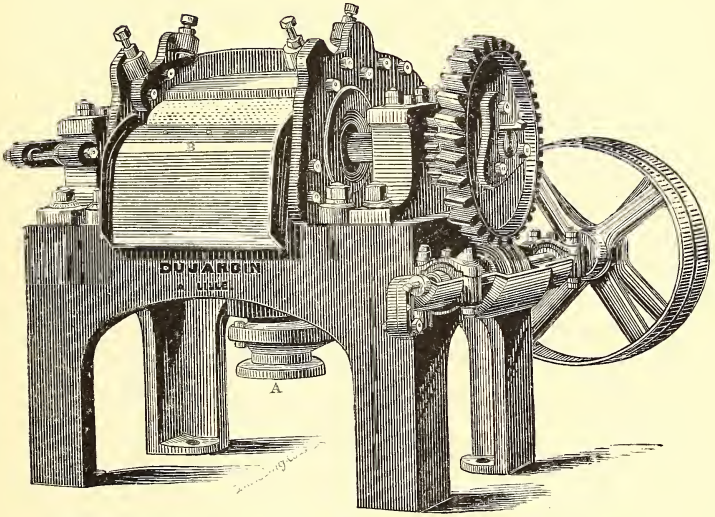


CHAMPONNOIS CONTINUOUS PRESS.—(MAUMENÉ.)

I. Transverse section. *II.* Longitudinal section: *a*, of the pressing-cylinder; *b*, through axis of surrounding case.

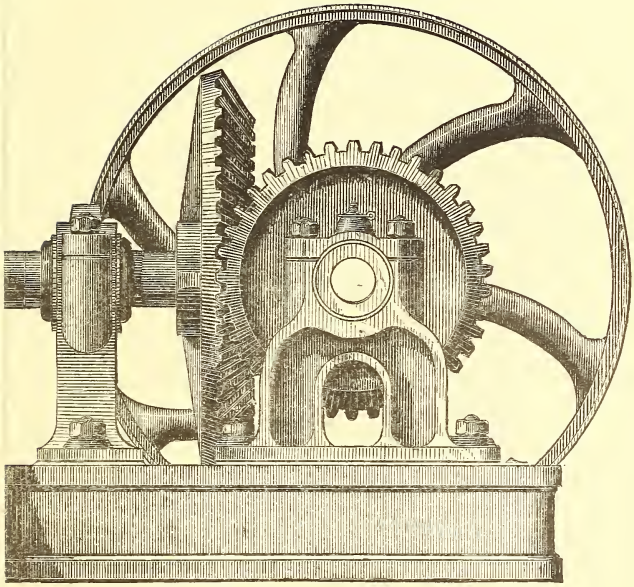
PLATE XX.

FIG. 33.



DUJARDIN CONTINUOUS PRESS.—(LA SUCRERIE INDIGÈNE.)

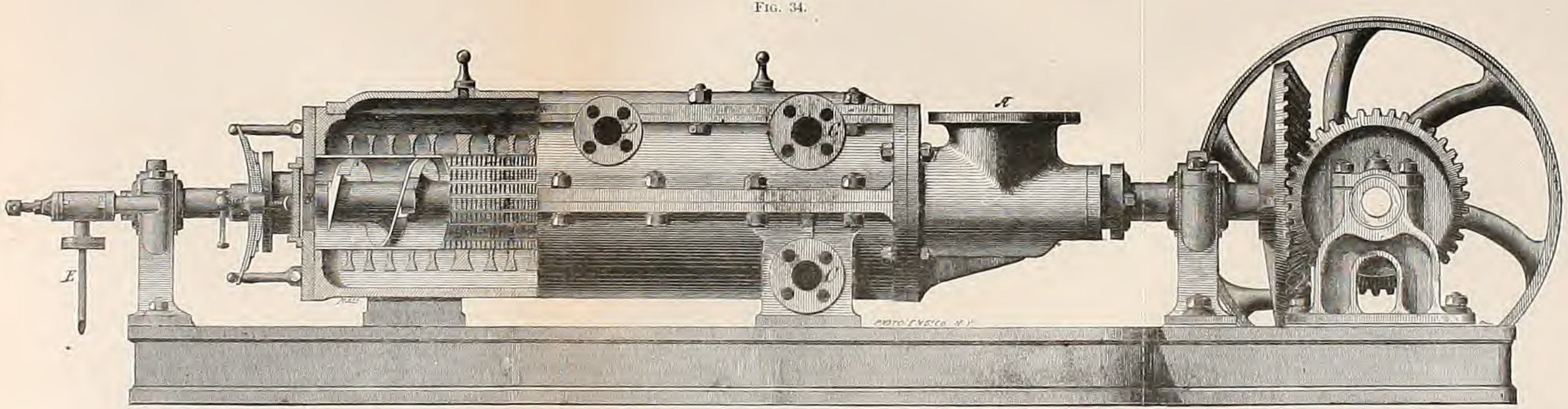
A. Entry of pomace.
B. Exit of pulp.



r of screw.

PLATE XXI.

FIG. 34.

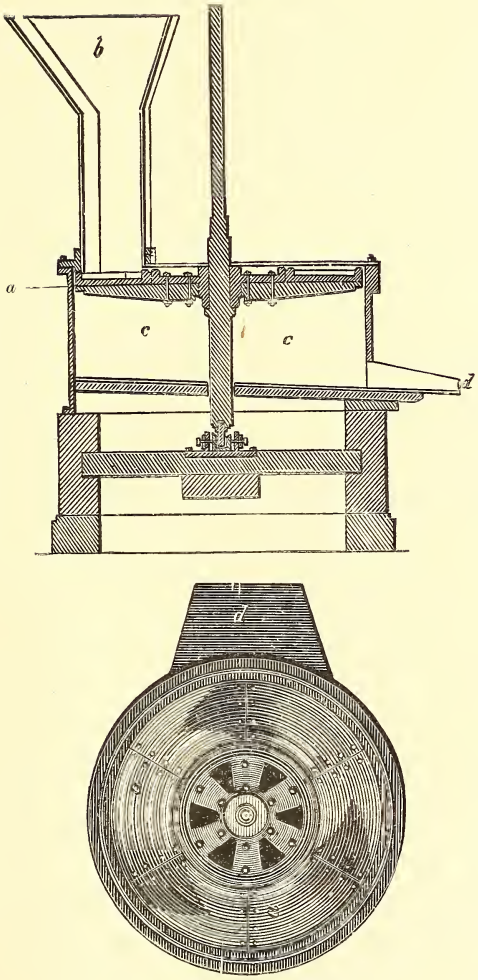


PIÉRON CONTINUOUS SCREW PRESS.

A. Entry of pomace. *B.* Exit of pulp *C C.* Exits of juice. *D.* Entry of water for washing. *E.* Supply of water for injection through center of screw.

PLATE XXII.

FIG. 35.

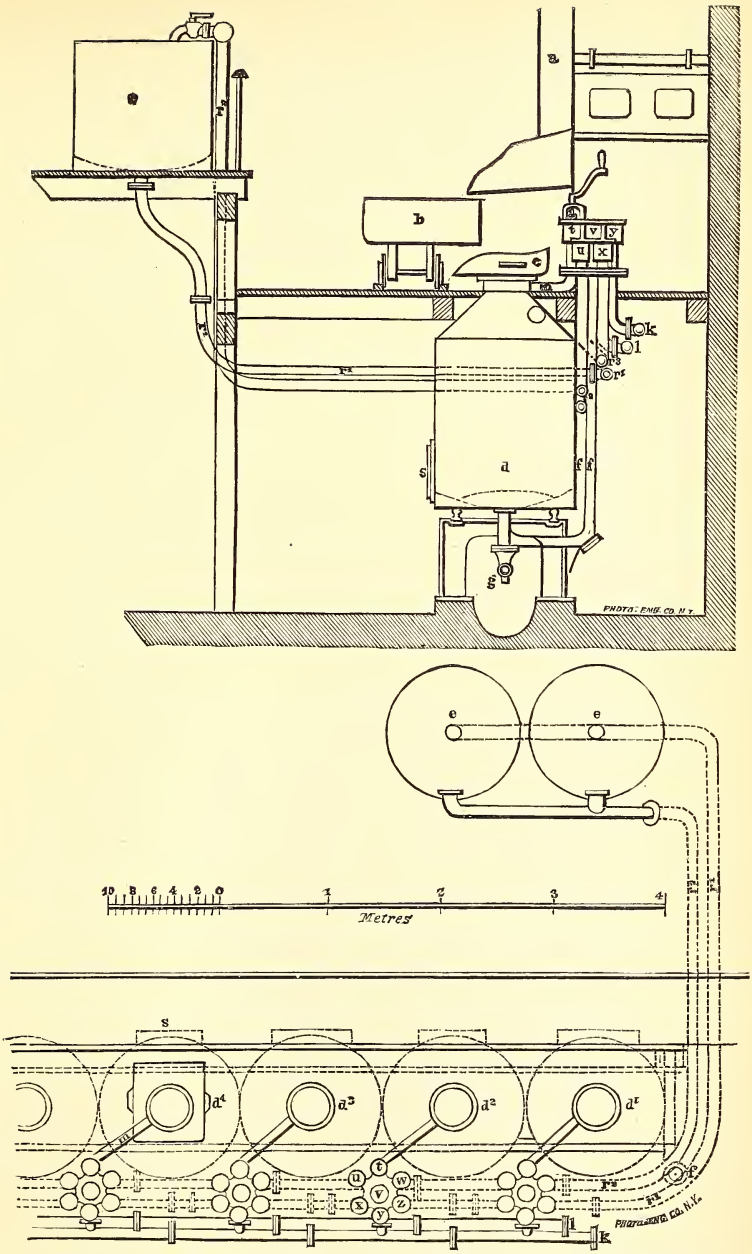


ROOT CUTTER.—(STAMMER.)

a. Cutting-plate.
b. Feed-hopper.
c. Reservoir of slices.
d. Exit of slices.

PLATE XXIII.

FIG. 36.

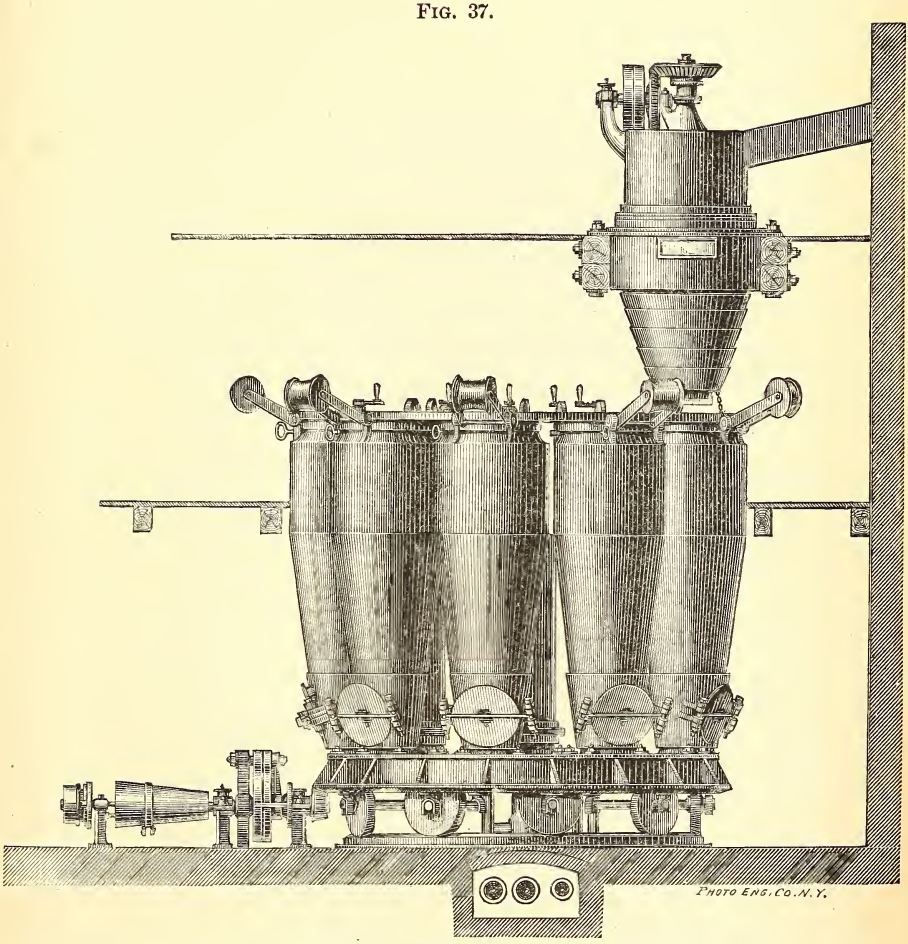


VERTICAL AND HORIZONTAL SECTIONS OF ROBERT'S DIFFUSION BATTERY.—(STAMMER.)

a. Root-cutter. b. Charging-car with weighing attachment. c. Movable hopper. d, d^1, d^2, d^3, &c. Diffusers. e. Reheating-reservoir. f. Communicating-tubes between diffusers. g. Discharge-tube. k. Conducting-tube for displaced water or juice. l. Safety-tube connecting with all the diffusers, and serving to disconnect a defective one. t, u, v, x, y, z. Valves corresponding to the various tubes. m. Tube joining valves with diffusers. r^1 and r^2, &c. Conduits between reheaters and diffusers. w and u. Valves corresponding with same. r^3. Conduit of juice to defecators. s. Manhole for exit of exhausted slices.

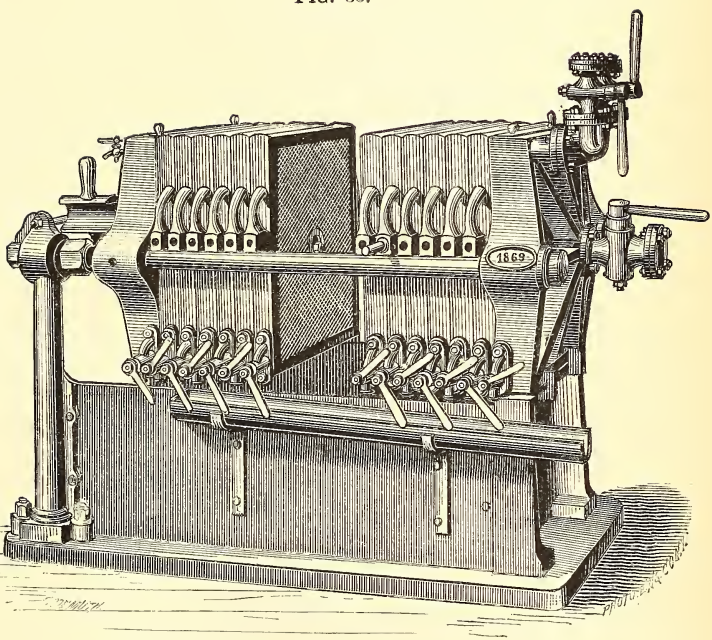
PLATE XXIV.

FIG. 37.

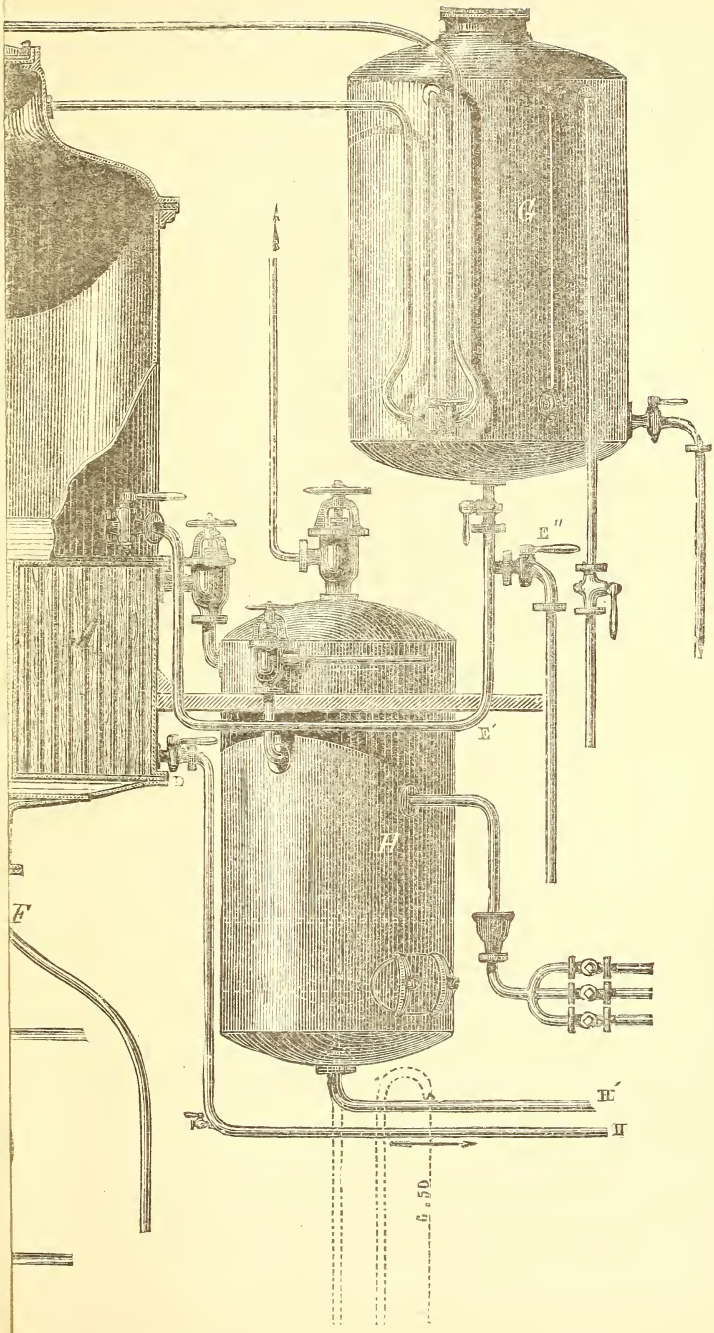


ROTATIVE DIFFUSION BATTERY.—(JOURNAL DES FABRICANTS DE SUCRE.)

FIG. 38.



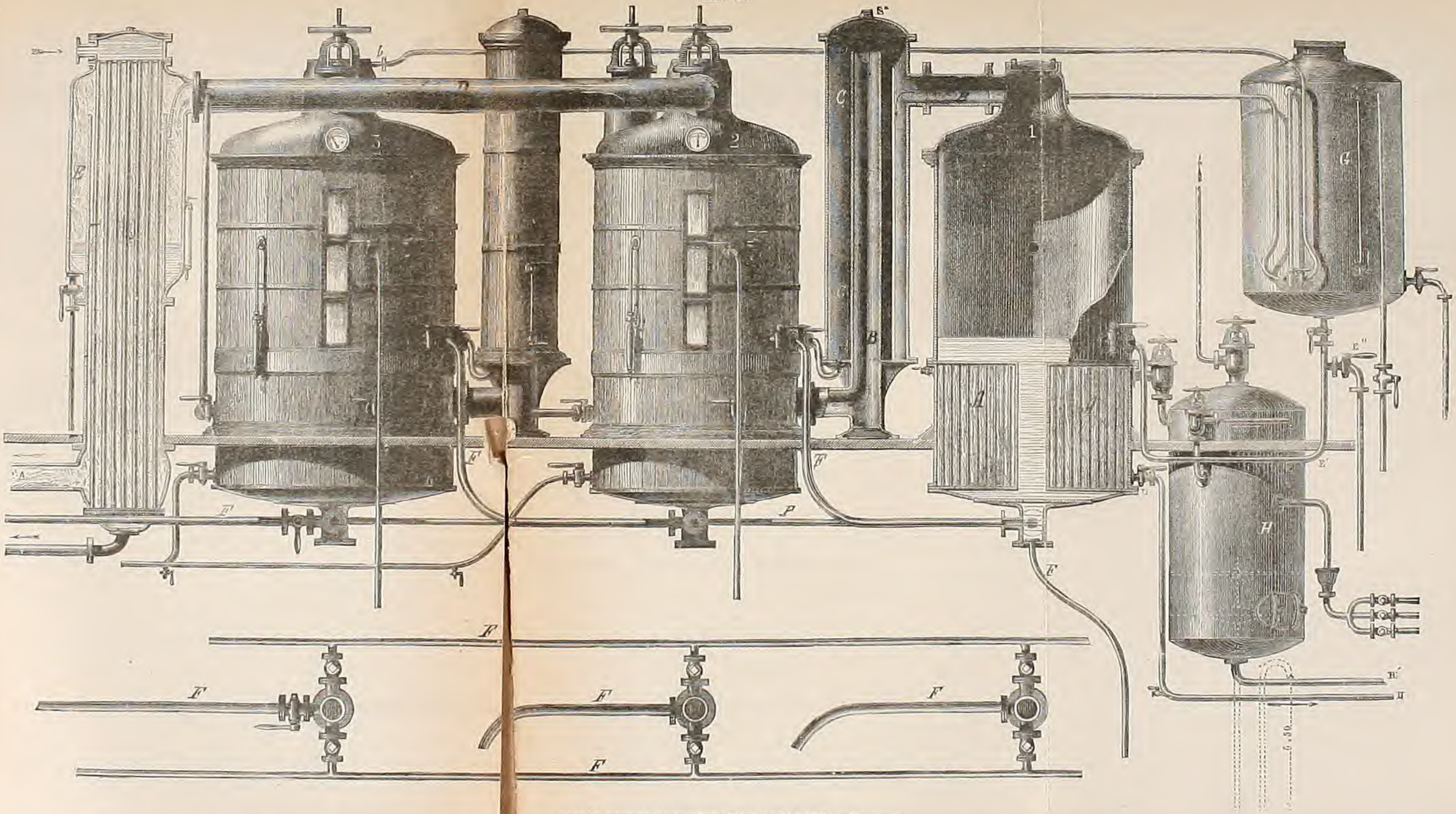
FARINAUX FILTER PRESS.



s or spray that may pass over. D. Pipe connecting 2 and 3, so arranged that the
. G. Juice-tank. H. Steam-condenser.

PLATE XXVI.

FIG. 39.

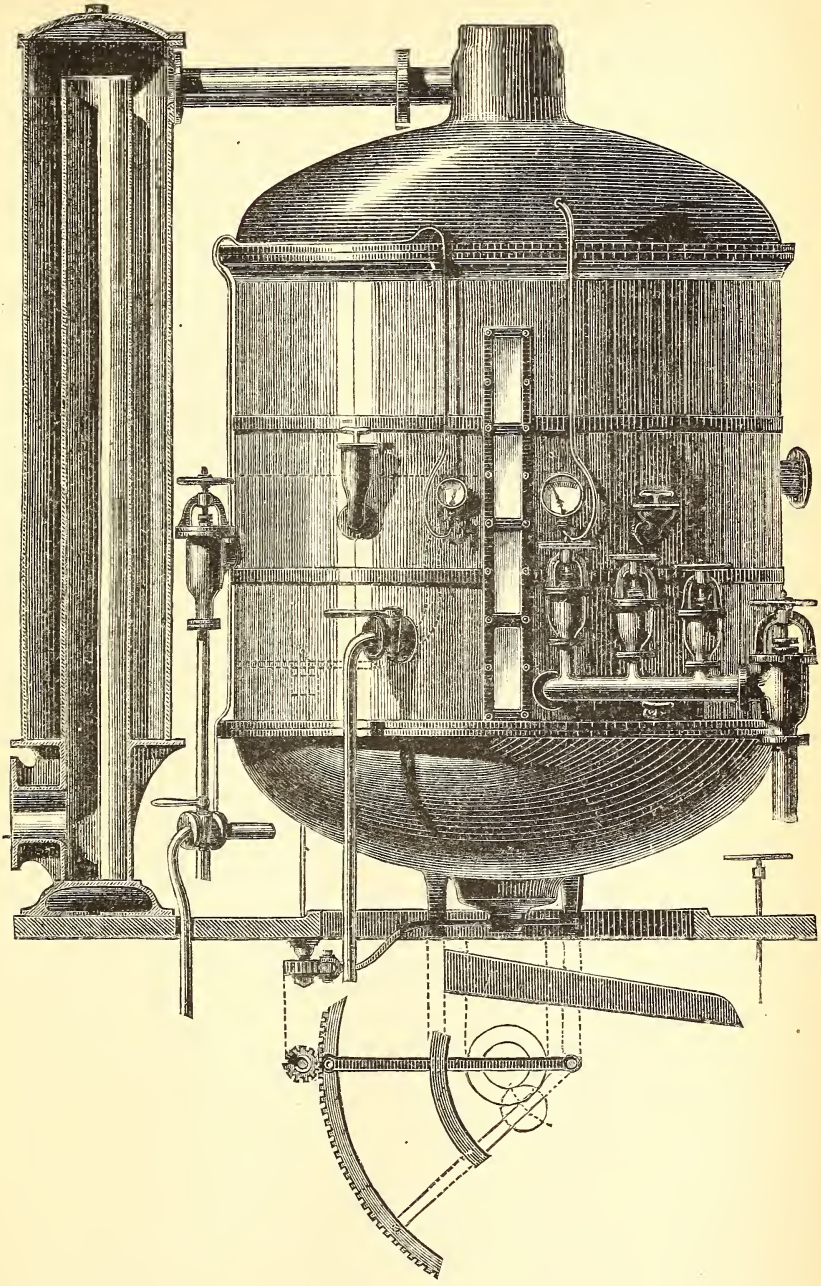


TRIPLE EFFECT CONCENTRATING APPARATUS.—(MAUMENÉ.)

1, 2, and 3. Vacuum-pans of similar internal construction. A A. Steam-chest traversed by small ...es for heating vacuum-pan. B B. Tube connecting pans. C. Safety-jacket and condenser for collection of drops or spray that may pass over. D. Pipe connecting 2 and 3, so arranged that the apparatus may be made single, double, or triple effect at will. E. Chest for condensation of steam f... vacuum-pans; also used to heat juice before defecation. F F F F F. Tubes for charging and discharging pans. G. Juice-tank. H. Steam-condenser.

PLATE XXVII.

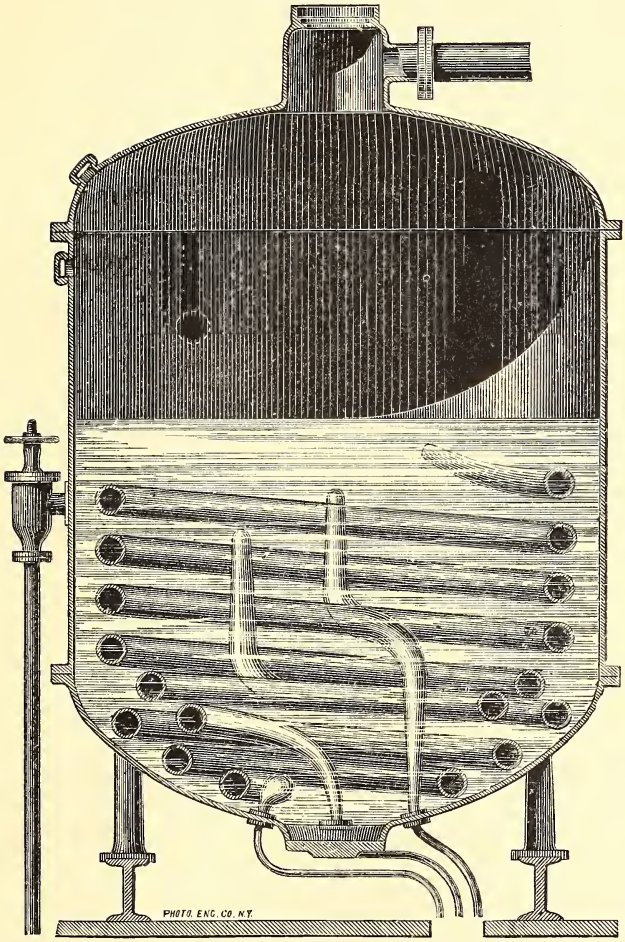
FIG. 40.



VACUUM STRIKE PAN.—(MAUMENÉ)

PLATE XXVIII.

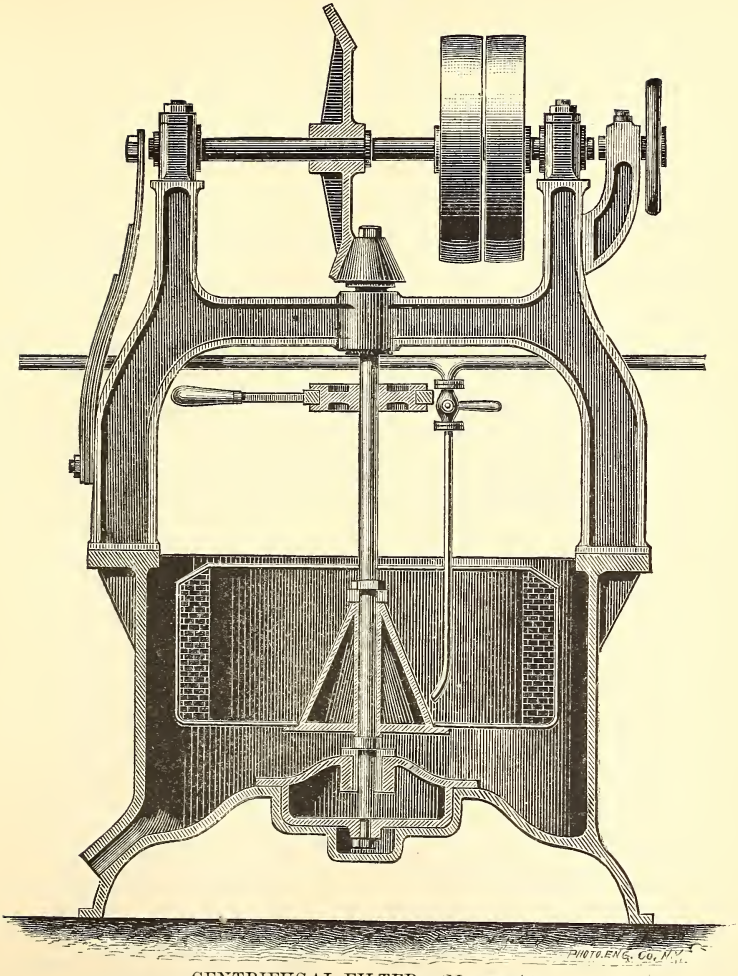
FIG. 41.



VACUUM STRIKE PAN, VERTICAL SECTION.—(MAUMENÉ.)

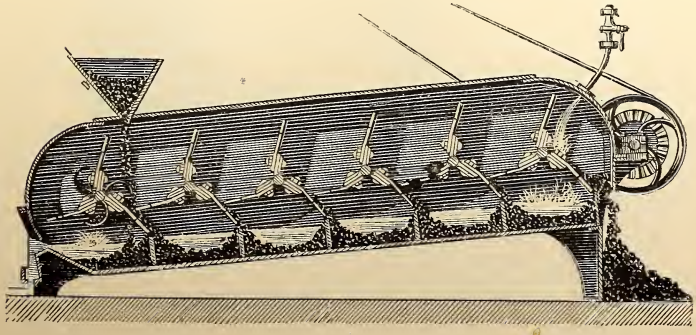
PLATE XXIX.

FIG. 42.



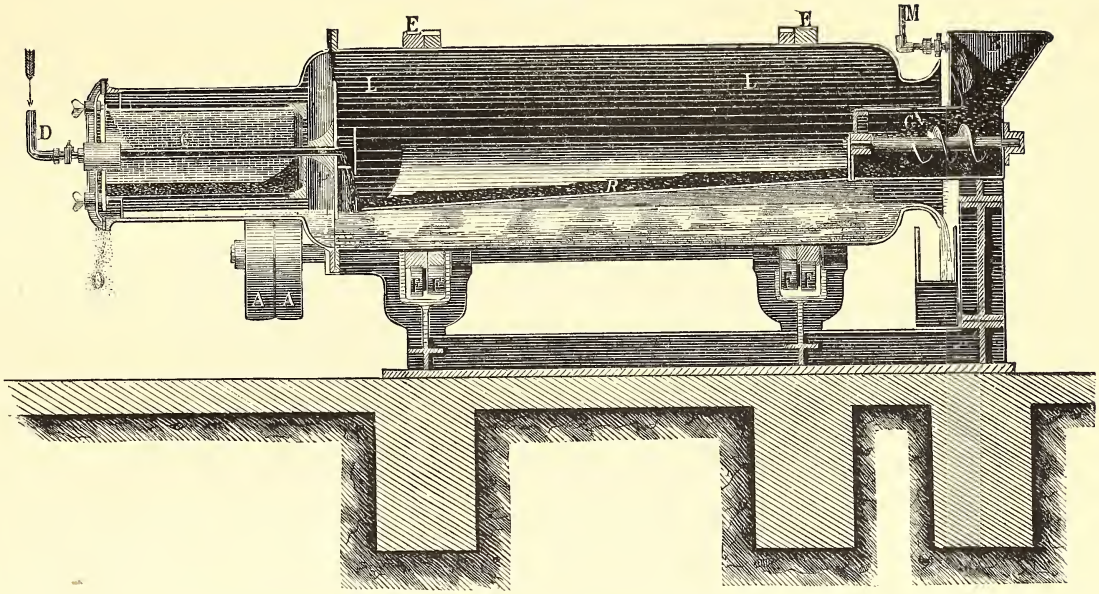
CENTRIFUGAL FILTER.—(MAUMENÉ.)

FIG. 43.



KLUSEMAN'S CONTINUOUS CHARCOAL WASHER.—(MAUMENÉ.)

FIG. 44.



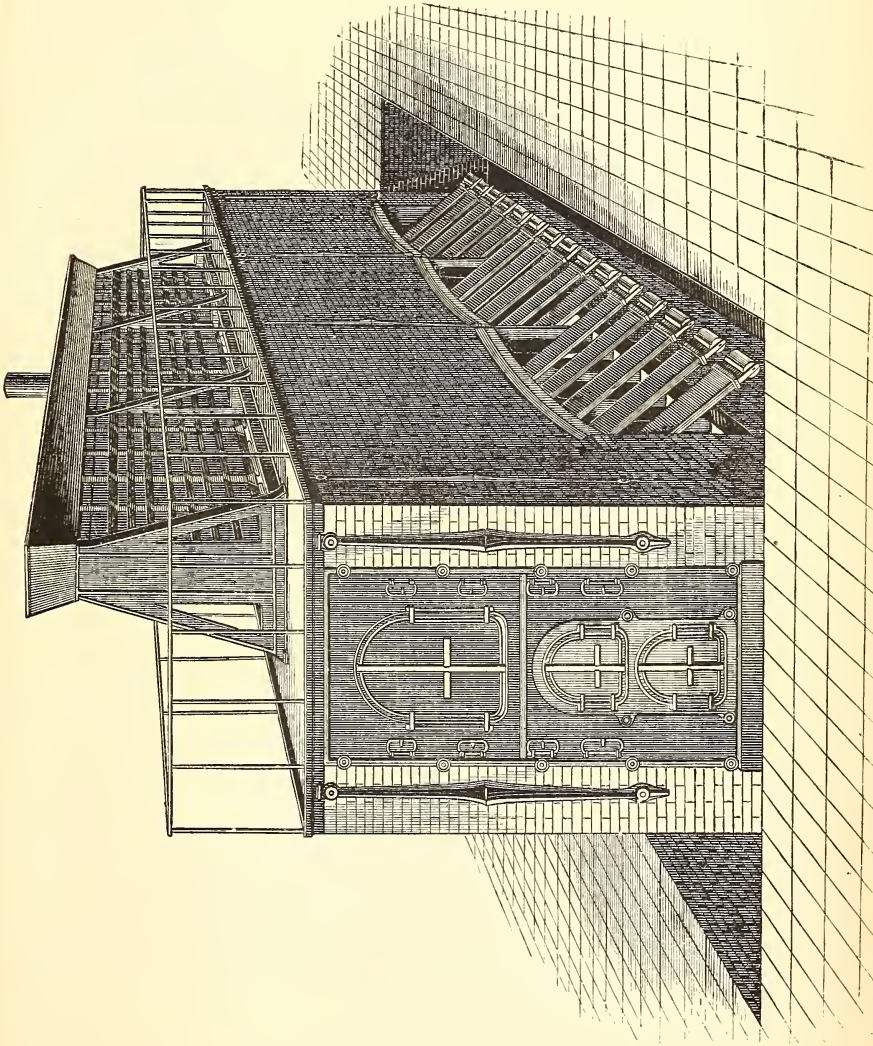
SCHREIBER'S ROTARY CHARCOAL WASHER.—(LA SUCRERIE INDIGÈNE.)

L L. External cylinder. E E. Smooth bands for support on rollers F F. A A. Pulleys for communicating motion. M and D. Water-supply tubes. B. Receiving-hopper. G. Conveying-screw. C. Screen for draining charcoal. P. Cylinder-enveloping screen. O. Exit of washed charcoal. R. One of two broad curved flanges attached to cylinder, slightly inclined toward to discharge end.

PLATE XXX.

PLATE XXXI.

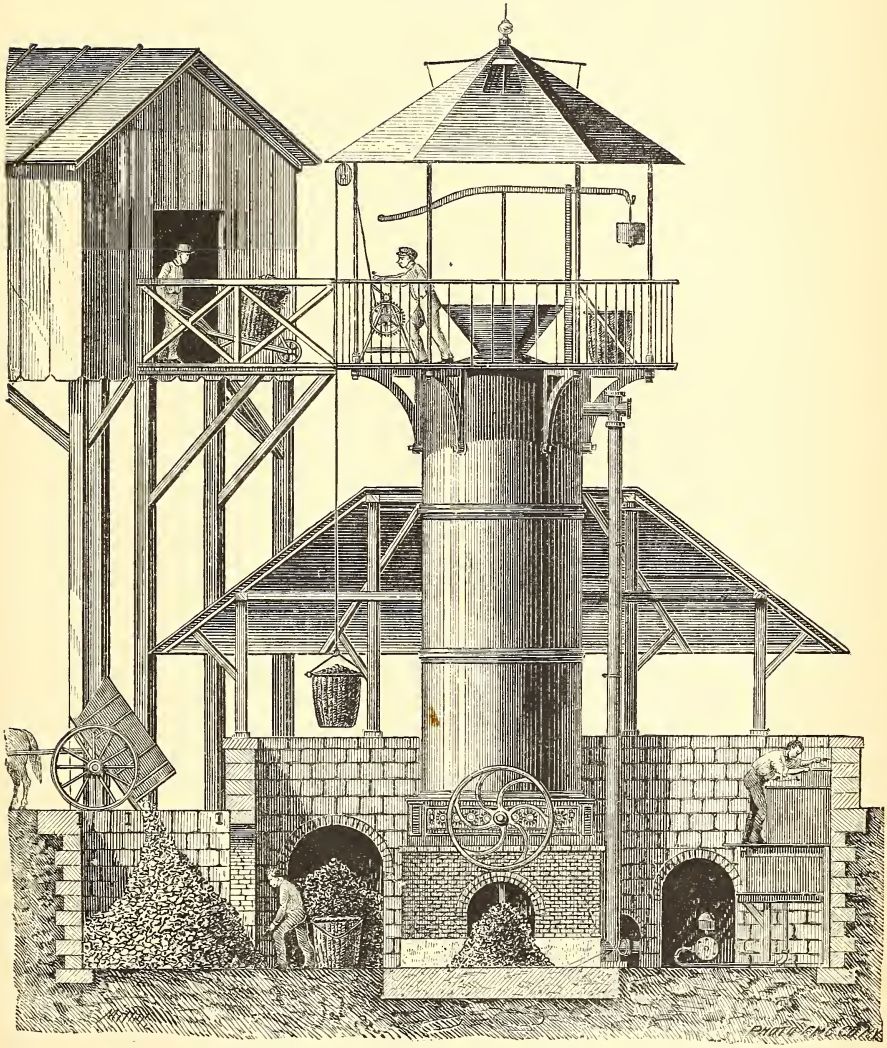
Fig. 45.



SCHREIBER'S FURNACE FOR REVIVIFYING CHARCOAL.—(Journal des Fabricants de Sucre.)

PLATE XXXII.

FIG. 46.



FURNACE FOR SUPPLY OF LIME AND CARBONIC ACID GAS TO FACTORY.
(JOURNAL DES FABRICANTS DE SUCRE.)

APPENDIX B.

HISTORY AND PROGRESS OF THE CULTURE OF THE SUGAR BEET AND THE MANUFACTURE OF SUGAR THEREFROM IN THE UNITED STATES OF AMERICA.

Notwithstanding the progress that has been made in Europe in the culture of the sugar beet and the manufacture of beet-root sugar, and immensity and value of the industry it has supplied to European nations, the knowledge and experience resulting has not been applied in such a way in the United States as to make the production of sugar from this source a matter of any commercial or industrial importance, although attempts at the introduction of the industry have not been wanting. In most cases the attempts, which have had varying success or rather failure, seem to have been originated and guided by enthusiasm rather than by sound judgment, based upon a previous close study of all the conditions which should influence or absolutely govern the success or failure of the enterprise. This is very evident from a review of the records we have of the various experiments which have been made both on a large and a small scale.

The first experiment made by two enterprising Philadelphians as early as 1830, was almost cotemporaneous with the final firm establishment of the industry in France and the great interest manifested in it there, but it seems that these gentlemen were wholly ignorant of the requirements either of the culture of the root or the extraction of sugar, and failure was the natural result of their efforts.

Eight years later, David Lee Child, who had spent a year and a half in the beet-growing districts of Europe in careful study of all the requirements, both of culture and manufacture, undertook in a small way the production of beet-root sugar at Northampton, Mass. He was attracted by the method of drying the roots that had lately been invented by Schutzenbach, both for the purpose of preserving them and for facilitating the extraction of sugar, but being unable to obtain from Schutzenbach any information concerning the details of the method unless he would purchase the exclusive right to use in the United States, and give security for payment in case success should be obtained in a model factory, Mr. Child operated the method with apparatus of his own device, by means of which he was able, with a temperature of 150° to 185° Fahr., to dry 800 pounds in twenty-four hours. The dried product was ground, treated with three times its weight of water, and subjected to pressure, giving, it was said, a liquid twice as rich in sugar as the ordinary juice of the beet. In his little work entitled The Culture of the Beet and the Manufacture of Beet Sugar, Mr. Child informs us that the cost of culture in the Connecticut River Valley was, in 1838 to 1839, $42 per acre, with an average yield of 13 to 15 tons; that the crop yielded 6 per cent. of sugar and 2½ per cent. of molasses, and the cost of the sugar 11 cents per pound, pulp and manure not taken into account. But he does not mention the surface sown in beets nor the quantity worked up. From other sources, however, we learn that the quantity of sugar obtained was 1,300 pounds.

The interest in the beet-sugar industry in the United States seems to have been quite dormant, or at least not sufficiently strong to manifest itself in active work, and its subsequent history, which, as before stated, was a rather checkered one, began in 1863 with the inauguration of the well-known enterprise at Chatsworth, Ill., by the Gennert Brothers, formerly of Braunschweig, Germany, and later of New York City, which, on account of the ill-chosen location as regards soil and climate, really the

two principal conditions of successful culture, failed after a struggle of nearly six years. Bad management and lack of practical knowledge of the industry in the first few years, bad culture in 1868, deluging rains in 1869, and drought in 1870, in addition to the abundance of nitrates found to exist in the soils, appear to be the causes tending to the disastrous result. As a final struggle to maintain an existence the company removed the works to Freeport, in Stephenson County, of the same State, and though the saline character of the soil, which was a bane to the culture in the former locality, did not exist here, the efficient management of the able superintendent could not provide against the unfavorable climatic influences, and one year later the Germania Beet-Sugar Company finally succumbed, and its superintendent removed with some of the machinery of the late company to Black Hawk, Sauk County, Wisconsin, to join with the co-operative enterprise that had been started there a year before. But the lessons of experience appear to have been no guide, for this attempt was made, like the previous ones, in a section not provided with the principal requirements for successful work.

The crop of 1870 partially failed through drought. The machinery for the utilization of what there was arrived late, and the ponds upon which the company relied for water supply dried up before all the roots were worked for sugar, and a portion was left to be fed to cattle. Though additions were made to the works during the following year by means of machinery brought from Illinois and Fond-du-Lac, the result of 1871 does not seem to have been profitable, for since that time the enterprise has been so completely lost sight of that it is impossible to obtain any further information concerning it. The experiment at Fond-du-Lac, which, however, was not long continued, seems to have been the first to give unquestionably good results. It was started by two Germans, Messrs. Bonesteel and Otto, who organized a company with $12,000 capital, and though compelled, with their limited means, to work on a small scale, their success was such during the two years of existence of the enterprise as to attract the attention of capitalists on both sides of our continent, and they received an offer from Philadelphia of funds to carry on the work where they had so successfully established it, and another from San Francisco to put them in charge of the works of the Alvarado Sugar Company, which had just been organized with a capital of $250,000, and, finding the latter offer the most tempting, they abandoned their works at Fond-du-Lac and migrated to the Pacific coast, where they managed to carry on the work with varying success until 1873, when it was reported that the company proposed removing to a more eligible locality. But it does not appear that this proposition was carried out, for what reason we are not informed; though Mr. Otto, who was then superintendent, and who, with his colleague in the Fond-du-Lac enterprise, Mr. Bonesteel, had become partners in this company, was shortly afterwards transferred to Soquel, in Santa Cruz County, where as late as 1876 the factory was reported as being in successful operation. The Alvarado Company struggled on until 1876, when drought having destroyed the crop so completely that there was no raw material for work in the factory in the ensuing winter, the company not having realized enough to enable them to carry over until the following season, failed financially, and permanently closed their operations.

The Sacramento Valley Company was organized in 1869, and commenced extended operations in manufacture in 1870, and its existence was maintained until the close of 1875, when the machinery, which had cost $160,000 in Germany, was offered for sale at $45,000, and we have no information to the effect that it has been sold. Concerning the industry, a writer in the Alta California during 1869 says: "Something new and unexpected has revealed itself. In Europe the beet attains its maximum of sugar in the latest period of growth before the frost sets in. Here it has lost half its sugar in the last six weeks—last of October. The beets taken from the same soil and milled in December by Wadsworth, superintendent, had the full complement of sugar."

The Soquel factory soon followed the fate of the others, but causes of its failure have not been assigned.

The importance the manufacture attained in California is shown in the following statistics of beet sugar produced, published in 1874 by the State Agricultural Society:

	Pounds.
1870	500,000
1871	800,000
1872	1,125,000
1873	1,500,000

But nothwithstanding these figures, which are certainly flattering to the industry, there has not been a factory in operation in the State since 1876, and the capital invested in the manufacture, nearly one million dollars, has been a total loss, the causes of which may undoubtedly be traced to conditions determined in the department during the present year by the study of European history and practices to be manifestly unfavorable and decidedly deleterious to the successful prosecution of the industry. We refer more particularly to the meteorological conditions prevailing during the season of growth, which, as appears from the relations worked out, have a clearly defined influence for good or for evil, for success or failure, in the culture of the sugar beet, and it is an interesting fact to note that at none of the localities where the experiments made have been attended with failure are the prevailing meteorological conditions found within the limits determined to be favorable to or governing the extension of successful culture.

The experiments made up to this time received no aid or encouragement either from the State governments or from the general government, with the exception of the provision that no machinery purchased abroad and imported for manufacture of sugar from the beet in this country should be subject to customs duty, and the limited assistance given by the Department of Agriculture, in contributions of seed of the better varieties for experiment, and such information on the subject of the culture of the root and the manufacture of sugar as could be obtained by the means at hand; but this limited assistance was not of a character to produce any very marked effects.

In 1870 to 1871 the States of New Jersey and Massachusetts made legislative provision exempting from taxation for ten years from date all capital and property engaged in the beet-sugar industry, but no practical results seem to have followed this provision. In New Jersey, however, Mr. Joseph Wharton, of Camden, has during the past three years devoted a portion of his estate at Batsto to some very intelligent experiments in the culture, which, as regards the quantity of the product, have given unsatisfactory results, and only tend to show that the climatic conditions of the section, possibly combined with the light character of the soil, are not such as to render the permanent establishment of the industry in that locality possible.

In 1876 the Canadian Government offered a premium of one cent per pound for all sugar manufactured from the beet-root, the total sum paid to any one individual company or corporation not to exceed, however, $7,000 per annum.

This premium stimulated the culture of the crop and the establishment of factories, which have continued in active and profitable operation.

The State of Maine followed the worthy example of its near neighbor, and in the same substantial terms; the Forest City Sugar Refinery at Portland hastened to take advantage of the premium offered, and the experiment on a small scale in the manufacture, by the company, as had been the culture by the farmers in 1878, resulted in such brilliant success that the company have this year so enlarged the capacity of their works as to enable them to work 150 tons of roots per day, and have secured from the farmers a crop from 1,250 acres of land. Their success has also animated the people of Massachusetts, who have organized a company for work at the locality of Child's experiment of 1838–'39, at Northampton, Mass.

In 1876 and 1877 Delaware appropriated $300, and in 1878–'79 $1,500 to be expended in premiums, &c., to stimulate the culture, and the result has been the establishment of the Delaware Beet Sugar Company at Wilmington.

In California, also, interest in the industry has again been awakened through the instrumentality of Mr. Th. Gennert, whose worthy enthusiasm led to the establishment of the enterprise in Canada and in Maine. The work is to be renewed at the factory of the former Alvarado Company, and Gennert's scheme for drying the beets for preservation and transportation, which was attended with such disastrous results at Chatsworth and in Maine, is to be tried once more. It is understood that Mr. Gennert is now interested in the Alvarado Company and expects to carry out his plan for drying the beet-roots, and, thus diminishing the cost of transportation, increase the profits of manufacture, in which we hope he may be successful. The culture of the beet has also been undertaken in Santa Clara County, where it is proposed to supply deficient moisture by irrigation, and to dry in open sunlight the roots, of which it is declared two crops can be produced in one year. Without wishing to discourage the enterprise in any way, we may venture to express the hope that the promoters are acquainted with the experience of the growers of the south of France and Italy, as described by Gustave Heuzé in his work "*Les Plantes Fourragères*," page 9, where he says: "The beet succeeds well in the cold climates of Europe. It will grow in southern countries, but it suffers there from heat or drought; its root remains small, green, and contains little sugar. An attempt was made to hasten its growth in Lombardy by frequent irrigation during the summer, but irrigation was fatal to it, and growers were forced to adopt other means to assure success."

We would also call attention to the fact that in Algeria where the enterprise of preparing beets for preservation and transportation by drying in open sunlight, the success, if any was obtained, has not appeared worthy of record.

Besides the arrangements that have been made for the production of sugar from the beet at the different places mentioned active interest has been awakened elsewhere, particularly at Baltimore, Md., Chester, Pa., and at various localities in New York, but these movements have not yet assumed definite shape.

APPENDIX C.

PRELIMINARY REPORT UPON THE CONDITION OF THE CULTURE OF THE SUGAR BEET NEAR PORTLAND, ME.

WASHINGTON, D. C., *October* 5, 1879.

SIR: In accordance with your instructions of August 26, I proceeded to Portland, Me., and made examination of the condition of the culture of the sugar beet in that vicinity, and have the honor herewith to submit a preliminary report upon that subject. On the return of circulars which have been distributed among the farmers growing beets for the Maine Beet Sugar Company a more detailed report will be made.

Very respectfully,

WM. McMURTRIE.

Hon. WM. G. LEDUC,
Commissioner of Agriculture.

PRELIMINARY REPORT.

The inauguration of the enterprise of growing beets for the production of sugar in the vicinity of Portland, Me., occurred in the spring of 1878 under the influence of the Maine Beet Sugar Company, which issued notice of organization on April 23, and was granted a charter by the State legislature May 11.

The plan of the company was to secure a limited crop in 1878, and work it with as inexpensive apparatus as could be procured and made effective to be used in connection with the Forest City Sugar Refinery. The German idea which has governed former experiments of this kind in this country, that of purchasing for the company a quantity of land sufficient to furnish the necessary supplies for a factory, was considered impracticable, and they determined to depend upon contracts to be made with the farmers for their supplies, and though the enterprise is a new one to the farmers large numbers appear to have been willing to cultivate small areas, but on account of an unfortunate delay in securing the seed for distribution (it had been ordered in Germany) and the consequent very late planting the crop was not a good one, and, therefore, not very profitable to the growers, and only about 1,000 tons were obtained to be worked up in the factory last year. The company suffered another discouraging experience in the way of the mode adopted for the preservation of the roots for working late in the season. The method proposed was to slice the roots and dry them, and by this means it was expected that larger quantities could be obtained from the fact that they could be transported greater distances, but the experiment resulted in disastrous failure. The drying oven experimented with was estimated to cost $800, but actually cost $5,000. It was stated to have a capacity of 25 tons per day and would dry but 7 tons, and the cost of working was about $6.50 per ton. The experiment was made in the Aroostook upon 500 tons of roots under the most favorable conditions, proving conclusively that the method is too costly to be employed for the purpose. Besides the cost involved in drying the roots, it was found more difficult to extract the sugar from the dried slices in the factory than from the roots worked in the green state.

But after all these discouraging circumstances the results obtained in the factory did much to counterbalance them. The roots produced and delivered, contained an average of 12½ per cent. of sugar and yielded nearly 10 per cent., in the extraction, of sugar of good grade, convincing the company that good roots could be produced,

and that if sufficient quantity could be obtained for work in the factory the enterprise could be carried on with profit to all concerned. They, therefore, proceeded to make arrangements for securing the machinery and apparatus necessary for working 150 tons of roots in 24 hours, and roots sufficient to supply a factory of this capacity. The process for extraction adopted is Robert's diffusion process, for which the apparatus of the most approved patterns, and with the latest improvements, was purchased at Halle in Germany. The works are adapted to the extensive buildings of the Forest City Sugar Refinery, and the glass-house adjoining, and will be ready for active work by the middle of October. It was proposed to make use of the vaults of the glass-house as a place for storage of roots during the winter, but upon later consideration, this, it was thought, would be found impracticable on account of the danger of collecting too large a quantity of roots in a single mass, and subjecting them in this way to the possibilities of heating, sprouting, or decay, and consequent loss in their sugar content. Arrangements will, therefore, be made with the farmers for storing the roots in trenches and delivering them as they may be needed.

As before stated, the German method for obtaining supplies, that of purchasing large areas of ground to be devoted to the culture, was considered impracticable on account of the large investment of capital involved, and the method followed by the French, though somewhat modified, has been adopted. The company appointed agents to call upon the farmers and make contracts with them for the roots produced on a given area, to be delivered either at the factory or the nearest shipping point. In this way contracts were made with about 1,700 farmers for the roots of 1,250 acres of land. When the agent of the company made the contract he delivered to the farmer the quantity of seed desired, to be paid for in the fall in beets from the crop produced.

The following are the forms of contracts employed in all the dealings with the farmers:

——— ——— P. O., Me., ——— —, 1879.

I agree to raise for the Maine Beet Sugar Company —— acre- of sugar-beets from seed furnished by them, and to deliver the beets next fall on the cars at ——— railroad station for five dollars per ton of 2,240 pounds of unwashed beets, as they come from the field.

——— ———.

[George S. Hunt, president; Henry B. Blackwell, treasurer; Ernest Th. Gennert, secretary and general superintendent.]

Office Maine Beet Sugar Company,
Portland, Me., ——— —, 1879.

We agree to buy of ——— ——— all the sugar-beets raised by him on —— acre- from seed furnished by us, and to pay for the beets cash on delivery on the cars at ——— railroad station next fall, five dollars per ton of 2,240 pounds of unwashed beets as they come from the field.

MAINE BEET SUGAR COMPANY,
Per ——— ———, Agent.

$——.] ——— ——— P. O., Me., ——— —, 1879.

For value received in sugar-beet seed, I promise to pay the Maine Beet Sugar Company, or order, in October next, ——— dollars and — cents in cash, or in sugar beets at the rate of five dollars per ton of 2,240 pounds of unwashed beets delivered on the cars at ——— railroad station.

——— ———.

The company agreed to pay $5 per ton for the roots delivered at the nearest shipping point (railroad station or wharf), and made arrangements with the freight agents at different points to receive, acknowledge, and forward the roots to the factory. If they be delivered by the farmer directly to the factory, the price paid is $6 per ton. The quantity delivered directly will, however, be small. The companies governing the

railroads centering in Portland allow very generous terms for transportation of the roots, and for any distance not exceeding 50 miles the rates are 50 cents per ton; while for distances of over 50 miles, and not exceeding 110 miles, the rates are 80 cents per ton. This admits of obtaining roots from very long distances, and they have this year been grown in small crops in the entire section extending from Farmington on the north to Haverhill, Mass., on the south, and from Orono on the east to Concord on the west. The pulp will be carried back to the farmers at the same rates for freight, and will be sold to the producers of roots at $1 per ton, which will afford them a cheap source of valuable cattle food.

In order that the farmers with whom contracts for roots were made might be instructed as to the methods of culture to be followed, the agents of the company delivered to each one, and to all others who might desire them, copies of the following circular:

HOW TO RAISE SUGAR BEETS.

PORTLAND, *March* 31, 1879.

To the farmers of Maine:

The Maine Beet Sugar Company is now ready to contract with farmers to supply them with genuine sugar-beet seed, and to pay them $5 per ton for the crop of beets, cash, on delivery at the nearest railroad station, or $6 per ton, cash, on delivery at the Forest City Sugar Refinery in Portland, either by wagon or vessel. The seed will cost 20 cents per pound, payable next fall in cash or beets. Fourteen pounds of seed will plant one acre.

Almost every farmer has raised beets, or mangel-wurzels, which require similar cultivation. In order to get a good crop, say 20 tons or more per acre, the needful conditions are, early planting, good manuring, deep plowing, thorough harrowing, plenty of seed, timely thinning-out, careful hoeing and weeding. With these seven conditions, a good crop is certain. We will name some of the farmers, among many others who raised satisfactory crops of beets from our seed last year:

	Tons per acre.
William Connor, Fairfield	20
Ira E. Getchell, North Vassalborough	20
W. W. Harris, Cumberland	22½
John B. Morrison, Farmington	40
Henry Piper, Benton	40
H. L. Crosby, Winslow	40
Charles B. Seavy, Benton	49½

Last year, however, many farmers planted too late, or upon land not in proper condition, or did not attend to thinning and weeding at the proper time. Of course they failed to get a satisfactory crop, as might have been expected under such conditions.

TIME OF PLANTING.

Early planting is specially important. The seed sprouts best in cool, moist weather. The young plant thrives in the rains of early spring. By early planting, the beets get the start of the weeds. At first the beet grows slowly, but when once fairly rooted it becomes very vigorous, so that, later in the season, after thinning and weeding, it will take care of itself. Early planting enables the farmer to get the thinning and weeding done before the haying season begins. Just as early in May as the soil can be thoroughly loosened and pulverized, the seed should be planted, in rows twenty-four or thirty inches apart, and covered from one-half to one inch deep. Land plowed the fall before can be got ready earlier, and is therefore preferable; but this is not absolutely necessary.

PREPARATION OF SOIL.

The soil should be a deep, mellow loam, free from standing water; clay loam and sandy loam are both good. The better the soil and the more highly manured the larger will be the crop. Any kind of dressing is good: old, well-rotted barn-yard manure, super-

phosphate, guano, fish-chum, bone-dust, leached ashes, or Stockbridge fertilizer. *Plow a little deeper than ever before.* If the plow is followed by a subsoil plow, so as to loosen what lies below to the depth of fifteen inches, without bringing it to the surface, so much the better. Clods should be broken up by the harrow, and a smooth surface obtained. Land which was plowed and manured last year is best. If sod land is used, turn sod bottom up, and bury it as deep as possible; thoroughly dress and pulverize the earth above the sod, leaving the sod to decay slowly below. We do not advise a sod-crop for beets, yet in some cases good returns have been had. In planting on sod land it would be well to plow twice in the same furrow, so as to bury the sod deep. Thus you get rid of the weeds. Afterwards plow or harrow in the manure and use superphosphate in the drills, so as to give the beets a fair start.

EARLY CULTIVATION.

After harrowing, as early as possible in May, get in the seed, so as not to let the weeds get the start of the beets. Lay out the rows straight. Nail, under a board, strips about 1 foot long, 2 inches high, and 1 inch thick, like runners under a sled; these strips should be at the distance the rows are to be apart, which may be as follows: Two 12-inch rows to begin with, followed by a 30-inch row, which is again followed by two 12-inch rows; and so alternate the one 30-inch row and the two 12-inch rows. The board is fastened tightly to a common one-horse cultivator or some other contrivance. If the strips do not cut deep enough to be easily distinguished, get a stone, or something else heavy, on the rig. Allow the strip on one side to go in the previously-made line. This arrangement is to secure easy cultivation; the horse to walk in the 30-inch row, and the cultivator to work at the same time the adjoining row on each side, thus cultivating at one time 54 inches in the two 12-inch and one 30 inch rows.

The field, thus prepared and marked, should be planted without unnecessary delay; first, because the soil loses the moisture quickly on its surface, which is required for germination of the beet seed; and, secondly, because every hour's delay gives the weeds a start over the crop.

The seed laid by hand or drill should be placed at an even depth of one-half inch, in no case over one inch deep. Planting by drill requires 14 pounds of seed per acre, and to use less is very bad economy.

Planting by hand requires less seed, but takes more time and labor. In planting by hand, proceed as follows: Cut a small stick 8 or 10 inches long; keep this stick in your left hand, in which you carry also a small bag with seed; take in the fingers of the right hand a few seeds and press them about once-half inch into the ground, using the whole hand to cover them up. In alternating one 30-inch row with two 12-inch rows, the planting in the row should be 8 inches apart, so as to secure 40,000 plants to one acre. The stick in your left hand will act as a guide, and, by using it occasionally, you will soon plant very nearly alike. This method is the best for cultivation afterwards with a horse, and the cultivators for working the three rows at one time will be furnished by the company at $12, and will save their cost the first year. It will take about three hours to cultivate one acre, and one cultivator will do for six neighbors.

A second method to plant sugar beets is to either drill or hand-plant all the rows 24 inches apart, and to have the plants in the row 8 or 10 inches apart; this will give 30,000 beets to the acre. The cultivation of one acre of beets by hand-cultivator or shovel-hoe will take one man one-half day, and where this is preferred the distance between rows should be two feet.

As soon as the plants can be seen above ground, run the cultivator or horse-hoe between the rows. This first cultivation is necessary, not so much to destroy the weeds as to break up the crust on the surface, in order to enable the air to penetrate the soil. A light hoeing is fully as good as the running of a cultivator between the rows. Farmers will understand the importance of this first early hoeing. It will greatly increase the yield and will gain ten days' time in the maturity of the crop.

THINNING OUT.

Careful thinning out at the right time is the most important part of the work. Mr. Charles B. Seavy, of Benton, who raised last year the heaviest crop of which we are informed, viz, at the rate of 49½ tons to the acre, planted his rows 30 inches apart and thinned out so as to leave each beet 10 inches apart in the rows. The best time for thinning the beets is when most of the roots have reached the size of a slate-pencil. If they have been planted by a drill in a continuous row the easiest way is to cut out the spaces with a sharp hoe. Stand with one foot on each side of the row and cut through the row from right to left, deep enough to make it sure that no beet cut will grow again. If the rows are over 18 inches apart, or alternately 12 inches twice and 30 inches once, as above suggested, the plants should be left from 8 to 10 inches apart in the row. Retain the best and largest plant in each bunch, removing all the rest. Take hold of it with your left hand and press it downward, while you take the others in the right hand. Give the bunch in the right hand a twist, as if you were turning a screw, and pull them sideways and upwards. Do not pull them straight up, because by doing so you will so loosen the one you wish to remain that it will take many days before it regains its strength. Be careful not to break off the leaves only, leaving the roots still in the ground, for these would grow again and cause double work. No two beets which grow close together ever amount to anything in weight. Therefore it is well, about a week after the thinning, to look over the field, and wherever two are found together one must be taken out.

The thinning can be done best after a rain, even if the land is too wet for any other work. It can be done by children as quickly as by grown people. But it should be done thoroughly and not too late. After the beets are the size of one's finger they cannot be disturbed without great injury. The thinning should be done before haying begins. When the beets are thinned out and have fairly started the crop is almost secured, for soon the leaves will attain their full size, will cover the ground, and by their shade will prevent the weeds from growing. Until then the ground should be kept clean and loose. Beets should be hoed or cultivated thoroughly more than once before thinning. No plant is more grateful for cultivation than the sugar beet, or yields a more bountiful harvest in return for care bestowed.

We can furnish Comstock's seed drill for planting for $6.50, payable in cash or beets next fall. This drill can also be converted into a cultivator. Messrs. Cameron & Co., Preble street, Portland, have got up a cultivator specially adapted to shallow cultivation between the rows; price, $12. These cultivators clean three rows at a time. They are drawn by a single horse and will clean an acre of beets in a few hours. One of these cultivators would be sufficient for six farmers, who might club together and order one by paying $2 each. Ordinary cultivators or shovel-plows for potatoes can be used.

Norton's hand seed-sower (retail price $1.25) is a very ingenious and effective implement. It will plant one acre in about three hours. It can be had of us or our agents by farmers who contract with us for $1, and it may be included with the seed in a note payable next fall in cash or beets.

Stockbridge's celebrated "Special Manure for Sugar Beets" or Bowker's "Hill and Drill Phosphate" we will supply to farmers, on receipt of the money with the order, at the rate of $5 per bag, of 200 pounds, delivered at any railroad station in Maine. Where no barnyard manure is used, apply four bags of Stockbridge manure to the acre. Sow it in drill or furrow, ridged up before planting the seed. Where three to five cords of barnyard manure are used to the acre, apply two bags of Stockbridge manure to the acre, sown as above.

Mr. W. W. Harris, of Cumberland, president of the State board of agriculture, gives his experience in raising sugar beets as follows:

I have raised beets every year for five years. I first raised the genuine sugar beets in 1878, to the extent of two acres. The soil is clay loam. In 1877 it was worn-out grass land, cutting only half a ton of hay to the acre. That spring (1877) I plowed it

and put in turnips, using no manure except Stockbridge's special manure for turnips. I got a fair crop. In the spring of 1878 I underdrained the land and then plowed it once 9 inches deep with Frye's No. 3 steel plow. Then I harrowed it thoroughly with Share's harrow. I marked out my rows 30 inches apart and 2 inches deep with a light horse-hoe. I then strewed Stockbridge's special manure for sugar beets in the drills, at the rate of three bags ($5 per bag) to the acre. I then covered the manure about 1 inch deep. I then ran my seed-drill over the fertilizer and used plenty of seed. This was late in May. My drill covered the seed about 1 inch deep. When the beets were about the size of a slate-pencil I thinned them out, leaving only one beet to each 8 inches in the rows. This thinning out and first weeding was the only work I did by hand. I afterwards cultivated them with horse-cultivator twice only. My crop was 22½ tons per acre. The only manure I have used on the land for the past two years has been the Stockbridge fertilizer. Upon land which was thoroughly manured last year a good crop of su gar beets can be raised with Stockbridge sugar-beet manure alone. I am going to plant 10 acres of sugar beets this year on contract with the Maine Beet Sugar Company. I shall use no other manure than the Stockbridge; it has the great advantage that it introduces no weeds. If barnyard manure alone is used, 8 or 10 cords per acre will be needed. With early planting and good cultivation at least 20 tons per acre should be an average crop of sugar beets in the State of Maine.

W. W. HARRIS,
President Maine State Board of Agriculture.

Every farmer who cultivates beets for the Maine Beet Sugar Company will please send his address by mail on a postal card to The Maine Beet Sugar Company, Portland, Me.

MAINE BEET SUGAR COMPANY.

The instructions given in the circular were pretty generally followed, though in some cases the farmers followed the teachings of their own experience in growing other root crops. Thus crops were planted upon low bottoms that were not very well drained, and even where very peaty soil prevailed. Such conditions, of course, insured roots of large volume, which, according to the experience of European growers and sugar manufacturers, are not compatible with high yields in sugar in the factory as compared with the number of tons worked.

But these difficulties will remedy themselves in time, and it remains to be seen what will be the value of the crops produced under the varying conditions that may be found. This we shall endeavor to learn definitely by means of a circular of questions we have prepared for distribution among the farmers who have grown beets this year, and hope to be able to make public the information we shall doubtless obtain in a subsequent more detailed report. For the present we must content ourselves with the comparatively limited information we were able hurriedly to obtain in a short time before the time for harvesting the crop had arrived. The prospects for an excellent crop are very favorable, and hopes of success and profit from the enterprise, both to the farmers and the manufacturers, run high. It is believed by all concerned that the average quantity obtained per acre from this year's crop will reach 15 to 20 tons, of very excellent quality, though the latter has not yet been accurately determined. Should the expectations be realized, the extension of the culture next year will be rapid and sure.

The seed purchased and distributed by the company consisted of seven-eighths "Imperial," obtained from Halle, in Germany, and one-eighth "Pink top," from the house of Vilmorin, Andrieux & Co., in Paris. Of these, the German seed seems to find greater favor among the growers, because it has not the property of growing out of the ground as much as the French variety. But the value of the two varieties for working in the factory remains to be determined.

The methods of culture adopted by the farmers may be briefly summed up as follows:

The seed was sown in drills from 18 to 30 inches apart, according to the notion of the farmer, and in quantity varying from 8 to 14 pounds per acre. The quantity of

seed to be used is a matter of considerable variance of opinion among the farmers, and a very important number believe it to be quite as well to sow the smaller quantity, provided the seed be of good quality. It is difficult, they say, to sow the larger quantity with the same regularity, though some farmers were met who considered it of advantage to pass the drill twice through the same row, in order to secure uniformity in the distribution, or at least to obviate the danger and difficulty of having bare spots in the field that must be filled up by transplanting, which is both tedious and unsatisfactory, or the space left must be lost. This method of sowing was said this year to leave the fields in which it was tried entirely free from the troublesome and not very sightly bare spots that so frequently prevail.

The other recommendations in the circular appear to be very generally carried out. The thinning, which it is stated may be done with a hoe, was effected in various ways, but many of the intelligent farmers argue in favor of thinning by hand. In this way they say it is possible to make a more careful selection, and leave only the largest and more vigorous roots, and also insure leaving only one root, whereas with a hoe two or more may be left in contact, a condition well known to have a deleterious influence, not only upon the quantity of the crop, but on the quality as well. The roots were left at distances from each other, according as it was the desire of the farmer to produce large or small roots, varying from 6 to 10 inches, 9 inches being about the average. The other methods of culture were carried out as directed in the circular.

The notions concerning the use of fertilizers are as various as those upon other matters. Stable manure is, of course, the favorite, and is applied at the rate of 5 to 8 cords per acre, and, for this year's crop, in the spring; but artificial fertilizers are also employed to some extent, Stockbridge's special fertilizer for sugar beets finding most favor, though Bradley's superphosphate is used to a very considerable extent. No special rule as to the quantity used and the mode of applying seems be followed. Two to three bags of 200 pounds are in most cases considered sufficient, sowed broadcast just before the final operations of preparation of the soil previous to planting. In a very few instances the artificial fertilizers were distributed in the rows in advance of sowing the seed, but, so far as we were able to learn, no appreciable difference could be noticed in the crops from the several modes of distribution.

More exact notions concerning the methods followed by the most intelligent and progressive farmers, and especially the cost of production and the probable profits to the farmers (which latter information it was our particular desire and object to obtain), may be gleaned from the following detailed results of interviews with Mr. W. W. Harris, president of the Maine State Agricultural Society, and residing at Portland, and from Mr. Hiram Hays, of Portsmouth, N. H. These gentlemen appear to have given the subject of the culture thoughtful attention, and their statements may be considered of great value.

By Mr. Harris:

"Planted 9 acres on good upland with equal parts of German and French seed at the rate of 15 pounds per acre. The land planted in beets was cropped last year as follows: grass, 2 acres; turnips, 2 acres; balance in corn. The corn crop was manured with Stockbridge's fertilizer for corn, but no stable manure was applied either to the crops of the previous year or to the beet crop. For the latter, however, Stockbridge's fertilizer for beets was distributed in drills at the rate of half a ton per acre, at a cost of $25, to be taken in the fall from the account for beets by the sugar company, who supplied the fertilizer.

"The land was plowed both in the fall and spring to a depth of 9 or 10 inches. In the fall plowing one man and team could plow 1½ acre per day, making the cost $2 per acre. The spring plowing was accompanied by subsoiling to a depth of 8 inches below the bottom of the plow furrow. The two operations, or rather the double operation of spring-plowing and subsoiling was done at a total cost of $4 per acre.

"Preparatory to planting the land was thoroughly harrowed with a Shares and Ran-

dall harrow, and marked out with a marker. Fertilizer was then distributed in the marks and lightly covered by means of a horse cultivator, and the seed sown upon it with a hand drill. The cost of harrowing was $2 per acre, and that of marking, distributing the fertilizer, and planting, $1 per acre.

"This year the roots were separated by a distance of 30 inches between the rows, and 8 inches between the roots, but next year these distances will be decreased. The first weeding was done with a hoe of special form, turned up at each side and double-edged, so that the laborer was able to utilize both the forward and backward stroke. This made the operation much more rapid and the work done more thorough, but by means of this implement it was impossible to remove the weeds that were in very close proximity to the roots, and this was effected by hand, with very little labor and very small cost. The thinning was done with a hoe of similar construction but narrower, and this operation and the first weeding together cost $3 per acre. All the subsequent work on the crop was done with a horse cultivator, which was employed three times. It was found that a man with a horse cultivator could go over 2 acres per day, making the cost of the work $1.50 per acre. The work on the crop continues about 3 weeks after the first weeding, during which the horse cultivator may be used three times, and after which the leaves cover the ground so completely that the weeds do not grow.

"The harvesting will be done in October, and the method of pulling will vary with the character of the ground; if it be mellow it will be done by hand, with no assistance, but if the ground be hard it must be loosened with the plow. The leaves are removed in the field by hand or with a knife, as the case may be. Boys are not strong enough to twist off the leaves as the men do, and must use a knife for the purpose. The roots will be stored in trenches until called for by the factory. The railroad station being on the farm, no cost is estimated for delivering. The price received for the crop is $5 per ton of 2,240 pounds.

"I shall use pulp from factory for cattle food, at a cost delivered on farm of $1.50 per ton.

"The wages of farm laborers is $13 per month, with board and washing, and $25 per month or $1 per day without board and washing."

Mr. Harris considers that if care be observed to keep the weeds down, the cost of culture of the sugar beet will not be more than 25 per cent. greater than that of corn or potatoes, but the probabilities are that in most cases the cost will not be as high as this. The data concerning the cost of beet culture given by Mr. Harris may be summed up as follows:

Seed, 15 pounds, at 20 cents	$3 00
Fertilizer	25 00
Fall plowing	2 00
Spring plowing	4 00
Harrowing	2 00
Marking and planting	1 00
First weeding and thinning	3 00
Cultivator with horse (3 times)	4 50
Total	44 50

By Mr. HAYS, of Portsmouth, N. H.:

"Planted 2 acres with French seed, *pink top*, but prefers the German seed, because the roots are generally larger, do not grow so much out of the ground, and will probably give a larger yield per acre. He planted the 14 pounds of seed furnished by the company, but considers this quantity too much, and that 8 pounds per acre is amply sufficient, for more than this cannot readily be sown.

"The soil devoted to sugar beets this year is a sandy loam, on well-drained upland.

A moist, rather stiff, soil is probably preferable for beets, because they are not likely to suffer so quickly from dry weather. This year was rather dry, particularly in August, and the leaves withered so much during the day that they did not recover at night.

"The plot upon which the beets was planted was cropped last year in turnips. For the beets, well-rotted barn-yard manure was applied in the spring, at the rate of 5 cords per acre, and well plowed in. The field contained a great deal of witch grass, but this was completely killed by the three plowings given. In usual practice will plow but twice, first in the fall, leaving it rough during the winter, without harrowing, to be crossed in the spring, followed by very thorough harrowing. In the application of stable manure, it will be preferable to put it on well rotted in the spring, immediately in advance of plowing. He uses besides this 400 pounds of Stockbridge's special beet-manure per acre; it costs $5 per bag, or $50 per ton. The artificial manure is sown broadcast and harrowed in.

"The first plowing was done this year at the last of April, and the second about a week later, both times to a depth of 7 inches, without subsoiling. It is questionable whether subsoiling pays. The cost of plowing is estimated at $2 per acre, and the harrowing at 50 cents to $1, according to the land.

"The seed was sown May 24 with Ross's horse corn planter at an estimated cost of $1 per acre, and the roots were separated by a distance of 18 inches between the rows, and 6 inches between the beets in the rows; but considers this too close, and next year will plant 22 by 7 or 8.

"Hoeing the crop was commenced as soon as the beets were large enough to admit of it, and was done both by hand and the horse cultivator. By means of a hand cultivator which was also used, a man was able to go over three times as much ground in a given time as he can with an ordinary hoe and do quite as good work. The horse cultivator was, however, used as much as possible. With an ordinary hoe a man can '*cut*' half an acre per day, and with the hand cultivator 2 acres. The thinning out is the most expensive operation of all. While mechanical appliances might be employed, it pays better in the end to do the work by hand, because then choice can be made to remove the smaller and weaker specimens, and leave only the stronger ones, which will make a great difference in the crop. The cost of thinning by hand may be estimated at about $7 per acre.

"The crop of this year was hoed three times at a cost of $2 per acre for each time, and the work of cultivation was finished about July 1, when the leaves completely covered the ground. The crop will be harvested about October 1, or a little later. In most cases it is better to pull by hand simply, but it is often worth the trouble to run a plow close to each row to loosen the ground and then pull. The topping is done by hand, by taking the root in one hand and the leaves close to the root in the other and twisting them off. This method is not as clean an operation as topping with a knife, but it satisfies the manufacturer and may be much more quickly done. A man can pull about ¼ acre per day and can top about 3 tons in the same time. The cost of pulling will amount to about $4 per acre. In the section around Portsmouth contracts may be made for pulling and topping for 1½ cents per bushel of roots.

"The average distance of the crops of the section from the railway station is 1½ miles. At this distance a man with a pair of horses can deliver 5 tons per day at a cost of 30 cents per ton or at a distance of 5 miles for 50 cents per ton.

"Stable manure delivered on the farm is worth about $6 per cord, though it may be made for less than this, but it must be estimated at this cost in general culture.

"The pulp is sold at the factory at $1 per ton and is delivered in Portsmouth at $1.50. It will cost 30 cents more to deliver it on the farm. He will this year stable 50 head of beef cattle to feed upon equal parts of hay, refuse malt from brewery, and pulp, with some corn, and will keep close account of weight of cattle per head, purchase price, daily rations, cost of attendance, amount of manure produced, ultimate weight of the cattle and selling price, and will report same to the department."

The account of cost of culture for one acre at Mr. Hays's estimate may be summed up as follows:

Seed, 10 pounds at 20 cents	$2 00
Stable manure and applying	16 00
Artificial manure	10 50
First plowing	2 00
Second plowing	1 50
All harrowing	50
Planting	50
First hoeing and thinning	9 00
Second hoeing	1 50
Third hoeing	1 50
Harvesting	10 00
Delivering 1½ miles distant	6 00
	61 00

It will be seen that the methods of culture followed by Mr. Hays are very thorough, and the figures for the cost generous estimates, and deducting the estimated cost of harvesting and delivering, these estimates agree so closely with those given by Mr. Harris that they may be accepted as about correct for the cost of sugar-beet culture in the Eastern States.

Now the most natural question concerning this matter from the agricultural side is, What will be the profits to the farmer from this new culture? The estimate may be made from Mr. Hays's crop. With the rows 18 inches apart, and the roots separated 6 inches in the rows, there will be 31,680 beets per acre, and they will have an average weight of at least 1½ pounds each, which would be equivalent to a yield of 21 tons per acre. The price for beets delivered at the station being $5 per ton, the money value of his crop will be $105 per acre; and there will remain, after deducting expenses of culture, a net profit of $44 per acre, which would seem to settle very satisfactorily the question of the profits to the farmer, resulting from this new and valuable crop.

But it remains for the harvest to determine how far these figures for the average quantity of the crops shall be confirmed, and this and other information we hope to be able to offer in a subsequent report.

APPENDIX D.

FINAL REPORT ON THE CONDITION OF THE BEET SUGAR INDUSTRY IN NEW ENGLAND UNDER THE DIRECTION OF THE MAINE BEET SUGAR COMPANY OF PORTLAND, MAINE.

WASHINGTON, D. C., ——— —, ——.

SIR: I have the honor to submit the following final report upon the condition of sugar beet culture in New England, under the direction of the Maine Sugar Beet Company of Portland, Maine.

In order to secure full information concerning their operations directly from the farmers, the following circular letter with list of questions was distributed to those whose names and addresses were furnished by the board of directors of the company mentioned. It will be observed that little or no information could be given by the farmers concerning preservation of the roots or feeding pulps from the factory. In this connection the experience of last year has been entirely new.

The following is a form and copy of the circular and questions sent out:

UNITED STATES DEPARTMENT OF AGRICULTURE,
Washington, D. C., October 1, 1879.

SIR: For the mutual benefit of those who have grown sugar beets during the season just closing, and those who may desire to undertake the culture of this valuable crop during the coming year, it is the desire of this department to secure the fullest possible information with relation to the crop of the present year, the methods of culture followed, their cost, and the results obtained, and to this end we respectfully and earnestly request that you will have the kindness to return as full and complete replies to the following questions as lies within your power. Replies may be entered in the blank column opposite the questions, and it is desirable that they be returned as soon as possible.

Very respectfully,

WM. G. LE DUC,
Commissioner.

QUESTIONS.

1. Kind of seed sown?
2. Source of same?
3. Quality sown per acre?
4. Location of field, upland or lowland?
5. Is your soil sand, limestone, clay, slate, or loam?
6. Is it well drained?
7. Is the drainage natural or artificial?
8. Area planted in sugar beets?
9. Crop on same land previous year?
10. Time of first plowing?
11. Depth of same?
12. Cost of same per acre?
13. Time of second plowing?
14. Depth of same?
15. Cost of same?
16. Was subsoil plowing employed?

17. Depth of same?
18. Note other operations of preparation of the soil, such as harrowing, rolling, &c., and cost of same?
19. Planting, date?
20. Method of; by hand or drill?
21. Cost of planting?
22. Distance between the rows?
23. Distance between the roots?
24. Was stable manure applied to the crop?
25. When and in what quantity per acre?
26. Was artificial manure applied?
27. When; how; what; how much; cost?
28. Time of first hoeing?
29. Done by hand or horse cultivator?
30. If special implement employed, describe it?
31. Cost of first hoeing?
32. Area hoed by each laborer per day?
33. Wages of laborers by day or month?
34. Time and cost of second hoeing?
35. Date and cost of third hoeing?
36. Date and cost of thinning?
37. How was thinning done; by hand, hoe, or special implement for the purpose?
38. Time of harvesting?
39. Mode of pulling, by hand or with instrument?
40. Surface pulled by each man per day?
41. Mode of removing leaves or tops; by hand or with knife?
42. Quantity topped by each laborer per day?
43. Total cost of harvesting per acre?
44. Per ton of roots?
45. Distance of crop from station, wharf, or factory?
46. Cost of delivering?
47. Price received per ton of beets?
48. Are beets preserved in trenches?
49. How long?
50. Cost of preparing trenches?
51. Pulp, how obtained?
52. Price of pulp at the factory?
53. Cost delivered on farm?
54. Estimated feeding value as compared with hay or corn fodder?
55. Mode of preserving?
56. Cost of same?
57. Mode of feeding?
58. To what animals fed?
59. Quantity per day per head?
60. What percentage of sugar do your beets contain?
61. What is their average size and yield per acre?
62. Place of sugar beets in your rotation of crops?

Please fill out the blanks in the following table, showing the comparative cost per acre of culture of sugar beets, corn, and potatoes:

Operations.	Beets.	Corn.	Potatoes.
First plowing			
Harrowing			
Second plowing			
Harrowing and rolling			
Marking and planting			
First weeding and thinning			
First hoeing or cultivating			
Second hoeing or cultivating			
Third hoeing or cultivating			
Pulling and topping, or harvesting			
Delivering at place of sale			
—— cords stable manure, at ——			
—— pounds artificial manure, at ——			
Other operations of culture			
Total cost of culture			
Quantity of product per acre —— tons, at ——			

Name of grower, —— ——; town, ——; county, ——; State, ——.

Of this circular over 1,300 copies were distributed to addresses furnished by the Maine Sugar Beet Company, and the number returned with replies worthy of being entered in our record did not exceed 200. The information thus received has been arranged in the following tables. The table A is intended for detailed record, and the table B is a condensation for more convenient reference and study of the principal conditions of the culture and the results obtained.

TABLE A.

CONDITION OF SUGAR-BEET CULTURE IN MAINE.

Number of entry	1	2	3	4	5
1. Kind of seed sown?	White sugar	Imported	Sugar beet	Sugar-beet seed	Sugar beet.
2. Source of same?	Germany	Maine Beet Sugar Co	.....	Furnished by company	Portland.
3. Quantity sown per acre?	12 pounds	14 pounds	14 pounds per acre	14 pounds per acre	14 pounds.
3a. Cost of same?	$2.40	$2.80	$2.80	$2.80	$2.80.
4. Location of field, upland or lowland?	Lowland	Lowland	Upland	Upland	Upland.
5. Is your soil sand, limestone, clay, slate, or loam?	Sandy	Sandy loam	Sandy loam	Loam	Loam.
6. Is it well drained?	Yes	Yes	Yes	Dry and light	Yes.
7. Is the drainage natural or artificial?	Natural	Natural	Artificial	Natural	Natural.
8. Area planted in sugar beets?	1 acre	½ acre	½ acre	½ acre	½ acre.
9. Crop on same land previous year?	Wheat	Corn	Beets and carrots	Corn, beans, potatoes	Potatoes.
10. Time of first plowing?	May 1, 1879	Broken up 1871	April	May 1	Middle of May.
11. Depth of same?	8 inches	8 inches	8 inches	9 inches	12 inches.
12. Cost of same, per acre?	$3	$4	$4	$2 per acre	$2.
13. Time of second plowing?	.....	.....	May 1	Only plowed once	.....
14. Depth of same?	.....	.....	2 inches	.....	.....
15. Cost of same?	.....	.....	$4 per acre	.....	.....
16. Was subsoil plowing employed?	No	No	No	.....	No.
17. Depth of same?	.....	.....	.....	.....	.....
18. Note other operations of preparation of the soil, and cost of same.	Harrowing, $1	.....	Rolling, $1.50	Harrowed 3 times, $1	Harrowed
19. Planting, date?	From May 12 to 16	May 10	About May 5	About May 1	May 30.
20. Method of—by hand or drill?	Hand	Drill	By hand in drill	By hand	Hand.
21. Cost of planting?	$5	.....	$1	$1.25	$6 per acre.
22. Distance between the rows?	2 feet	2½ feet	2 feet	20 to 25 inches	24 inches.
23. Distance between the roots?	6 to 8 inches	4 to 8 inches	6 inches	5 or 6 inches	6 to 8 inches.
24. Was stable manure applied to the crops?	Yes; cost $35	Yes; cost $15	Yes; cost $100	Partly	Hog manure.
25. When, and in what quantity per acre?	May, 1879; 7 cords acre	5 cords, planted in drills	20 cords	.....	32 loads at planting.
26. Was artificial manure applied?	Yes	Yes	None	Artificial	No.
27. When; how; what; how much; cost?	500 pounds; $10.75	Phosphate, 500 lbs., $6	.....	$5	.....
28. Time of first hoeing?	June 1	June 1	About May 15	June 1	July 3.
29. Done by hand or horse cultivator?	Hand	Both	Horse cultivator	By hand	By hand.
30. If special implement used, describe it	Hand-hoe	.....	.....	.....	.....
31. Cost of first hoeing?	$4	$2.50	$3 per acre	Not less than $2	$16 per acre.
32. Area hoed by each laborer per day?	30 rods	.....	.....	.....	⅛ acre.
33. Wages of laborers, by day or month?	$1.50 per month	$1 per day	.....	.....	$1 per day.
34. Time and cost of second hoeing?	Same as first	Last part of June	June 1; about $3	.....	July 20; same cost.
35. Date and cost of third hoeing?	June 25 and last	Last of July	Middle of July; $3	.....	Do.
36. Date and cost of thinning?	Thinned at last hoeing	Last of June; $1.50	Middle of June; $3	About July 10	Do.
37. How was thinning done; by hand, hoe, or special implement for the purpose?	Hand and hoe	By hand	By hand	By hand	By hand.
38. Time of harvesting?	October 1 to 8	October 25	October	Commenced October 27	October 25.

39. Mode of pulling, by hand or with instrument?	Hand	Hand	Hand	By hand	By hand.
40. Surface pulled by each man per day?	$\frac{1}{10}$ acre	10 square rods	$\frac{1}{2}$ acre		$\frac{1}{2}$ acre.
41. Mode of removing leaves or tops; by hand or with knife?	Both	By hand	By knife	With knife	Knife.
42. Quantity topped by each laborer per day?			3 tons		
43. Total cost of harvesting per acre?	$7.50	$5	$25 per acre	At rate of $3 per acre	$10.
44. Per ton of roots?	$45\frac{10}{10}$ cents per long rod	2,240 pounds		About $1\frac{1}{2}$ tons	
45. Distance of crop from station, wharf, or factory?	30 rods; wharf	$2\frac{1}{2}$ miles	5 mile from railr'd stat'n	5 miles from station	4 miles.
46. Cost of delivering?	10 cents per ton	60 cents per ton	$2 per ton		$2 per ton.
47 Price received per ton of beets?	$5 per ton of 2,240 lbs	$5	$5 per ton	$5 for 2,240 pounds	$5.
48. Are beets preserved in trenches?	Yes		Yes	Delivered when dug	$\frac{1}{2}$ lb.; 3 tons per acre.
49. How long?	One year				
50. Cost of preparing trenches?					
51. Pulp, how obtained?					
52. Price of pulp at the factory?			$1 per ton		
53. Cost delivered on farm?	$2 per ton				
54. Estimated feeding value as compared with hay or corn fodder?					
55. Mode of preserving?					
56. Cost of same?					
57. Mode of feeding?					
58. To what animals fed?					
59. Quantity per day per head?					
60. What percentage of sugar in your beets?	$12\frac{1}{2}$	12 to 14		Very small; 3 tons p. acre	
61. What is their average size and yield per acre?	16 tons per acre		15 tons		
62. Place of beets in your rotation of crops?					
63. Cost of culture per acre:					
a. Of beets?	$70.25	$45.20	$180.30	$17.05	
b. Of corn?					
c. Of potatoes?					
64. Value of crops per acre:					
a. Of beets?	$80	$70	$75	$15.00	
b. Of corn?					
c. Of potatoes?					
65. Average yield per acre:					
a. Of beets; tons?	16 tons	14 tons	15 tons		
b. Of corn; bushels?					
c. Of potatoes; bushels?					

CONDITION OF SUGAR-BEET CULTURE IN MAINE—Continued.

Number of entry	6	7	8	9	10.
1. Kind of seed sown?	Sugar-beet seed		Sugar-beet seed	Sugar-beet	Sugar-beet seed.
2. Source of same?	Maine Beet Sugar Co		Maine Beet Sugar Co	France	
3. Quantity sown per acre?	11 pounds	12 pounds	10 pounds	14 pounds	14 pounds.
3a. Cost of same?	$2.20	$2.40	$2	$2.80	$2.80.
4. Location of field, upland or lowland?	Upland	Lowland	Moist upland	Lowland	Upland.
5. Is your soil sand, limestone, clay, slate, or loam?	Loam	Sandy and clay	Loam	Clay and sand	Gravel.
6. Is it well drained?	Yes	No	Needs no drainage	Yes	Yes.
7. Is the drainage natural or artificial?	Natural			Artificial	Natural.
8. Area planted in sugar beets?	1 acre		½ acre	½ acre	½ acre.
9. Crop on same land previous year?	Corn		Potatoes	Potatoes, 2 years before	Potatoes.
10. Time of first plowing?	May 1	May 13	October, 1878	May 5	April 28.
11. Depth of same?	15 inches	About 11 inches	8 inches	Twice in furrow; 1 foot	10 inches.
12. Cost of same, per acre?	$4	$5	$2.50	$4.50	$2.50.
13. Time of second plowing?		In June	May, 1879		May 2.
14. Depth of same?		About 8 inches	12 inches		12 inches.
15. Cost of same?		$2	$2.50		$3 per acre.
16. Was subsoil plowing employed?	No		No	No	No.
17. Depth of same?					
18. Note other operations of preparation of the soil, and cost of same.	$4		Well harrowed; 75 cents		Harrowed and brushed; $1 per acre.
19. Planting, date?	May 10 to 15		About May 12	May 15	May 4 and 5.
20. Method of—by hand or drill?	Hand		Sowed by hand	By hand	By hand.
21. Cost of planting?	$5	$3	$3	$2.50	$4 per ½ acre.
22. Distance between the rows?	30 inches	2 feet	22 inches	25 inches	20 inches.
23. Distance between the roots?	4 to 10 inches; ought to be 10.	About 6 inches	6 to 8 inches	1 foot from center	8 to 10 inches.
24. Was stable manure applied to the crops?	Yes; cost $50	Barn-yard manure	Yes; cost $40	Barn-yard manure	Yes; cost $100.
25. When, and in what quantity per acre?	Before planting; 10 cords per acre.	About 50 loads; cost $80	In May; 8 cords per acre.	6 cords to ½ acre	20 cords per acre at first plowing.
26. Was artificial manure applied?	Yes	No	Yes	Yes	Yes.
27. When; how; what; how much; cost?	In drills; 400 lbs. to ½ acre; $2.50 per hundred.	Last of June	Time of planting; Stockbridge fertilizers; 250 pounds, $5.	July 1, by hand; ashes and fish.	200 pounds Stockbridge fertilizer, $5.
28. Time of first hoeing?	June 1		June 1	June 20	June 1.
29. Done by hand or horse cultivator?	Both	By hand	Horse cultivator		By hand.
30. If special implement used, describe it	1-horse cultivator				
31. Cost of first hoeing?	About $4 per acre	About $3	$2	$3	$4 per ½ acre.
32. Area hoed by each laborer per day?	¼ of an acre		¼ of acre	25 square rods	16 rods.
33. Wages of laborers, by day or month?	50 cts. per day and board	$1 per day	$1 per day	$1 per day and board	80 cents per day.
34. Time and cost of second hoeing?	2 men 4 days; $10	In July; cost $3	June 25 to 30; $2	August 1; cost $3	Last of June; hoed and thinned; $5.
35. Date and cost of third hoeing?	Last week in June; $5	August 22; $3			July 15; $4.
36. Date and cost of thinning?	do $5	In July; $3	Middle of June; $2	June 25; cost $3	Thinned at 2d hoeing.

37. How was thinning done; by hand, hoe, or special implement for the purpose?	By hand	By hand	Hand	By hand	First hoe, then hand.
38. Time of harvesting?	October 30	Middle of October	October 15 to 20	November 1	October 13.
39. Mode of pulling, by hand or with instrument?	By hand	By hand	Hand	By hand	By hand.
40. Surface pulled by each man per day?	$\frac{1}{10}$ acre, pulled and topped	$\frac{1}{2}$ acre per day	$\frac{1}{10}$ acre	10 square rods per man	$\frac{1}{4}$ acre.
41. Mode of removing leaves or tops; by hand or with knife?	Both	Knife	With knife	With knife	With knife.
42. Quantity topped by each laborer per day?		1 ton		1 ton	4 tons.
43. Total cost of harvesting per acre?	$10	$10	$10	$8	$8.
44. Per ton of roots?			About 85 cents	$1 per ton	40 cents.
45. Distance of crop from station, wharf, or factory?	2½ miles	1 mile from station	1½ miles	25 miles	2 miles.
46. Cost of delivering?	$15	$1 per ton	$1 per ton	75 cents per ton	75 cents per ton.
47. Price received per ton of beets?	$5	$5	$5	$6, delivered at sugar-house.	$5.
48. Are beets preserved in trenches?	No			Yes	
49. How long?				Until warm weather	
50. Cost of preparing trenches?					
51. Pulp, how obtained?					
52. Price of pulp at the factory?				$1 per ton	
53. Cost delivered on farm?	$2.50 per ton		$1.80 per ton		
54. Estimated feeding value as compared with hay or corn fodder?					
55. Mode of preserving?					
56. Cost of same?					
57. Mode of feeding?					
58. To what animals fed?					
59. Quantity per day per head?					
60. What percentage of sugar in your beets?					
61. What is their average size and yield per acre?	3 lbs.; 14 tons, 1,307 per acre.	About ½ pounds		9 inches in circumference	
62. Place of beets in your rotation of crops?					
63. Cost of culture per acre:					
a. Of beets?	$134.20		$77.75 per acre	$26.80†	$62.30.*
b. Of corn?			$28 per acre		$25.*
c. Of potatoes?			$22		$25.25.*
64. Value of crops per acre:					
a. Of beets?	$70		$30		$100.
b. Of corn?					
c. Of potatoes?					
65. Average yield per acre:					
a. Of beets; tons?			6 tons		20 tons.
b. Of corn; bushels?			do		40 bushels.
c. Of potatoes; bushels?					200 bushels.

* Not including stable manure.

† Not including cost of delivery.

CONDITION OF SUGAR-BEET CULTURE IN MAINE—Continued.

Number of entry	11	12	13	14	15
1. Kind of seed sown?	Sugar beet	German sugar beet	Sugar beet		Sugar beet.
2. Source of same?	Portland	Maine Beet Sugar Co	Maine Beet Sugar Co		
3. Quantity sown per acre?	14 pounds	8 pounds	10 pounds	12 pounds	
3a. Cost of same?	$2.80	$1.60	$2	$2.40	
4. Location of field, upland, or lowland?	Upland	Upland	Upland	Lowland	Upland.
5. Is your soil sand, limestone, clay, slate, or loam?	Clay loam	Clay loam	Gravel loam	Clay loam	Red loam.
6. Is it well drained?	No		No drainage required		Needs no drainage.
7. Is the drainage natural or artificial?	Artificial	Natural		Natural	
8. Area planted in sugar beets?	1⅞ of an acre	½ acre	¾ acre	½ acre	1 acre.
9. Crop on same land previous year?	Corn	Corn	Partly corn	Oats	Grass.
10. Time of first plowing?	May 20	November, 1877	About May 10	May 10	
11. Depth of same?	8 inches	7 inches	4 to 5 inches	6 inches	7 inches.
12. Cost of same, per acre?	$2	$2.50	$2	$2	$3 per acre.
13. Time of second plowing?	May 25	Nov. 1878, and May 15, '79			
14. Depth of same?	6 inches	About 8 inches			7 inches.
15. Cost of same?	$2	$2 per acre			$1.50.
16. Was subsoil plowing employed?	No	No	No	No	Yes.
17. Depth of same?					6 inches.
18. Note other operations of preparation of the soil, and cost of same?	Well harrowed	Harrowed, rolled, and furrowed; $2.	Thorough hoeing		Harrowed ½ of day; cost $1.50.
19. Planting, date?	From May 25 to June 10.	May 20, 1879	About May 25		May 15.
20. Method of—by hand or drill?	Drill	Small seed-drill	Hand	By hand	By hand.
21. Cost of planting?	$5		$4	$1.50	$3.50.
22. Distance between the rows?	26 inches	2 feet	2 feet	2 feet	24 inches.
23. Distance between the roots?	6 to 8 inches	3 to 12 inches; too thick	8 inches	8 inches	8 inches.
24. Was stable manure applied to the crops?	Yes; 5 cords per acre.	Barn-yard manure	To a portion	Yes; 4 cords	Yes.
25. When, and in what quantity per acre?	$25	16 cords per acre, cost $80	Before plowing; rate of 3 cords, cost $15.	$12	5 cords; cost $25.
26. Was artificial manure applied?	Yes; ½ ton per acre	250 lbs. Bradley's phos	Yes	Yes; cost $20 per acre	Yes.
27. When; how; what; how much; cost?	$22.50	Sown in drills at planting; cost $6.25.	Superphosphate at planting, ½ teaspoonful to each plant; $10.	In drill	4 barrels wood ashes; 200 pounds fertilizer.
28. Time of first hoeing?	From June 20 to July 1	Last of June		July 2	June 20.
29. Done by hand or horse cultivator?	By hand	Hand	Both	Horse cultivator	By hand.
30. If special implement used, describe it			None		
31. Cost of first hoeing?	$10 per acre	$3 per ½ acre	$3		$6.
32. Area hoed by each laborer per day?	⅓ of acre	About ⅓	½ acre		
33. Wages of laborers, by day or month?	$13 per month	$10 per month and board	$15 per month	$1 per day	
34. Time and cost of second hoeing?	Aug. 1; $5 per acre for weeding.	August; same cost			$6.
35. Date and cost of third hoeing?			Latter part of July		$5.
36. Date and cost of thinning?	Thinning done at first hoeing.	Thinning done at first hoeing.		July 8; $2	$8.

37. How was thinning done; by hand, hoe, or special implement for the purpose?	Hand	By hand, but not enough.	Hand	By hand and hoe	By hand.
38. Time of harvesting?	October 20	Last of October	October 15	October 16	October 25 to 30.
39. Mode of pulling, by hand or with instrument?	With plow	By hand	Hand	By hand	Spade-fork.
40. Surface pulled by each man per day?	½ acre	About ½ of an acre	½ acre		¼ acre.
41. Mode of removing leaves or tops, by hand or with knife?	Knife	Knife	Knife	With knife	With knife.
42. Quantity topped by each laborer per day?	2 tons	About 1 ton	About 2 tons		½ acre.
43. Total cost of harvesting per acre?	$10	About $3 per ½ acre	$4	$16	$12.
44. Per ton of roots?			40 cents	$1.75	12 tons.
45. Distance of crop from station, wharf, or factory?	2 miles	1 mile to station	12 miles	3 miles from station	½ mile.
46. Cost of delivering?		75 cents per ton	75 cents per ton	$1 per ton	50 cents per ton.
47. Price received per ton of beets?	$5	$5 per gross ton, 2,240 lbs.	$6 (2,240 pounds)	$5	$5.
48. Are beets preserved in trenches?	No		They are at factory		
49. How long?			Several months		
50. Cost of preparing trenches?			25 cents per ton		
51. Pulp, how obtained?					
52. Price of pulp at the factory?					
53. Cost delivered on farm?					
54. Estimated feeding value as compared with hay or corn fodder?					
55. Mode of preserving?					
56. Cost of same?					
57. Mode of feeding?					
58. To what animals fed?					
59. Quantity per day per head?					
60. What percentage of sugar in your beets?					
61. What is their average size and yield per acre?	14 tons	1 pound; 14 tons per acre.	10 tons	12 tons	
62. Place of beets in your rotation of crops?					
63. Cost of culture per acre:					
a. Of beets?	$84 30	$116.85	$47.50	$67.90	$77.50.
b. Of corn?					$70.
c. Of potatoes?					$30.
64. Value of crops per acre:					
a. Of beets?	$70	$70	$60	$60	$60.
b. Of corn?					
c. Of potatoes?					
65. Average yield per acre:					
a. Of beets, tons?	14 tons	14 tons	10 tons	12 tons	12 tons.
b. Of corn, bushels?					40 bushels.
c. Of potatoes, bushels?					100 bushels.

CONDITION OF SUGAR-BEET CULTURE IN MAINE—Continued.

Number of entry	16	17	18	19	20
1. Kind of seed sown?		Sugar beet	Long white beet		Sugar beet.
2. Source of same?	Germany	Portland	Maine Sugar Beet Co.	Germany	Portland.
3. Quantity sown per acre?	6 pounds	6 or 7 pounds	10 to 12 pounds	12 pounds	10 pounds.
3a. Cost of same?	$1.20	$1.40	$2.40	$2.40	$2.
4. Location of field, upland, or lowland?		Upland	Up and low land	Sloping south	Upland.
5. Is your soil sand, limestone, clay, slate, or loam?	Sandy loam	Sandy loam	Clay loam	Black loam	Sand loam.
6. Is it well drained?	Yes	Well drained	Yes	Yes	Yes.
7. Is the drainage natural or artificial?		Natural	Natural	Natural	Natural.
8. Area planted in sugar beets?	⅔ of an acre	1 acre	½ acre	1 acre	½ acre.
9. Crop on same land previous year?	Corn and forage beets	Potatoes, corn, wheat	Grass	Barley and oats	Sweet corn and potatoes.
10. Time of first plowing?		April 20	October 10, 1878	May 4	May 6.
11. Depth of same?	14 inches	6 inches	8 inches	6 inches	1 foot.
12. Cost of same, per acre?	$4 per acre	$2.50	$2	$1.50	$5 per acre.
13. Time of second plowing?					May 10.
14. Depth of same?	14 inches				4 inches.
15. Cost of same?	$4 per acre				$3 per acre.
16. Was subsoil plowing employed?	No		No	No	No.
17. Depth of same?					
18. Note other operations of preparation of the soil, and cost of same.	75 cents		Used cultivator; 8 inches deep.		Harrowing and rolling; $6 per acre.
19. Planting, date?	June 1	May 10	May 15	May 10	May 12.
20. Method of—by hand or drill?	By hand	Drill	By hand	Drill	By drill.
21. Cost of planting?	$7 to $8	$5	$2.50	50 cents per acre	$3.
22. Distance between the rows?	18 inches	15 inches	2 feet	22 inches	2 feet.
23. Distance between the roots?	Average, 8 inches; ought to be a foot.	8 inches	10 inches	8 inches	8 inches.
24. Was stable manure applied to the crop?	Yes; plowed in at the rate of 8 cords to the acre; in drill, as much more.	Manure 1 year old	Yes	Yes	Barn-yard manure.
25. When, and in what quantity per acre?	8 cords; $40	In drill; 8 cords; $40	20 loads; $30	In spring; 8 cords p. acre	From 7 to 8 cords p. acre.
26. Was artificial manure applied?	S. phos. lime; $20 p. acre.		Yes	Yes; $40	$40.
27. When; how; what; how much; cost			At time of planting; in drill; used Bradley's S. phosphate; 200 lbs. to ½ acre; cost, $5.	800 pounds; Stockbridge fertilizer; $20.	
28. Time of first hoeing?		May 25		June 20	June 1.
29. Done by hand or horse cultivator?	By hand	Horse-cultivator	Cultivator	By hand and cultivator	By hand.
30. If special implement used, describe it			Nine-tooth harrow		
31. Cost of first hoeing?	$3	$4	50 cents		$7.50 per ½ acre.
32. Area hoed by each laborer per day?	⅛ of an acre	⅛ acre per day		⅛ per acre	1/12 of an acre.
33. Wages of laborers, by day or month?	$10 per month	$1.25	$12 per month and board	$15 per month and board	$1.25 per day.
34. Time and cost of second hoeing?		June 7; $4	2 hours; cost, 50 cents	July 15; 4 days; 75c. p. day	12 days; $1.25 per day.
35. Date and cost of third hoeing?					July 1; cost, $10.

36. Date and cost of thinning?	$14 or $15 per acre	June 14; $4	June 3	June 10; cost, $3	July 1; cost, $2.50.
37. How was thinning done; by hand, hoe, or special implement for the purpose?	Hand	By hand	By hand	With hoe	By hand.
38. Time of harvesting?	October and November	Oct. 25, 26, 27	October 20, 1879	October 26 to 30	October 23, 24, 25.
39. Mode of pulling, by hand or with instrument?	Hand and fork	With fork	Hand	By hand	By hand.
40. Surface pulled by each man per day?	$\frac{1}{25}$ of an acre	$\frac{1}{3}$ acre	6 rows 20 rods long	$\frac{1}{4}$ acre	$\frac{1}{4}$ per acre.
41. Mode of removing leaves or tops; by hand or with knife?	With knife	Knife	Knife	Knife	With knife.
42. Quantity topped by each laborer per day?		$\frac{1}{3}$ acre		1 ton	2 tons.
43. Total cost of harvesting per acre?	$20	$4	$8		$15.
44. Per ton of roots?	$2.25				$2 per ton.
45. Distance of crop from station, wharf, or factory?	$1\frac{1}{4}$ miles from station	$1\frac{1}{2}$ miles from station	1 mile from station	1 mile	4 miles.
46. Cost of delivering?	50 cents per ton	$6 per acre	$2 per acre	75 cents per ton	$12 per acre.
47. Price received per ton of beets?	$5 per ton of 2,240 lbs.	$5	$5 for 2,240 pounds	$5	$5 per acre.
48. Are beets preserved in trenches?	Yes			Yes	
49. How long?	Till they grow or rot			Until December 15	
50. Cost of preparing trenches?					
51. Pulp, how obtained?					
52. Price of pulp at the factory?			$1.80		80 cents.
53. Cost delivered on farm?	$2.25		$2	$2.25	$2.30 per ton.
54. Estimated feeding value as compared with hay or corn fodder?					
55. Mode of preserving?				In pits secure from air	
56. Cost of same?					
57. Mode of feeding?					
58. To what animals fed?					
59. Quantity per day per head?					
60. What percentage of sugar in your beets?					
61. What is their average size and yield per acre?	1 lb.; 12 tons per acre	6 tons; half crop; killed by worms.	3 inches; 8 tons	Yield, 12 tons	Yield, 16 tons.
62. Place of beets in your rotation of crops?			The poorest		
63. Cost of culture per acre:					
a. Of beets?	$119.95	$64.15	$61.90	$79.40	$128.50.
b. Of corn?	$30				$27.50.
c. Of potatoes?	$20				$24.
64. Value of crops per acre:					
a. Of beets?	$60	$30	$40	$60	$80.
b. Of corn?					
c. Of potatoes?					
65. Average yield per acre:					
a. Of beets, tons?	12 tons	6 tons	8 tons	12 tons	16 tons.
b. Of corn, bushels?	100 bushels		125 baskets		50 bushels.
c. Of potatoes, bushels?	80 bushels		250 bushels per acre		100 bushels.

CONDITION OF SUGAR-BEET CULTURE IN MAINE—Continued.

Number of entry	21	22	23	24	25
1. Kind of seed sown?	French sugar beet	Sugar-beet seed	German sugar beet		French and German.
2. Source of same?	Maine Beet Sugar Co		Portland		Maine Beet Sugar Co.
3. Quantity sown per acre?	About 10 pounds per acre	14 pounds	14 pounds		10 to 12 pounds.
3a. Cost of same?	$2	$2.80	$2.80		$2.40.
4. Location of field, upland, or lowland?	Upland	Upland	Lowland		
5. Is your soil sand, limestone, clay, slate, or loam?	Sandy loam	Clay soil	Loam	Clay loam	Clay loam.
6. Is it well drained?	Yes	Yes	Yes	Nearly level	Yes.
7. Is the drainage natural or artificial?	Natural	Natural	Artificial	Natural	Both.
8. Area planted in sugar beets?	½ acre	½ acre	¼ acre	78 square rods	4 acres.
9. Crop on same land previous year?	Corn	Potatoes	Potatoes	Oats	Beans, potatoes, cabbage.
10. Time of first plowing?	May 1	May 2	October	June, 1878	About May 1.
11. Depth of same?	8 inches	10 inches	8 inches		12 to 15 inches.
12. Cost of same, per acre?	$2.50	$3	$3		$2.
13. Time of second plowing?			May	May 5, 1879; $1.50	
14. Depth of same?	10 or 11 inches		8 inches		
15. Cost of same?	$2.50 per acre		$2.50 per acre		
16. Was subsoil plowing employed?	No	No	No	No	
17. Depth of same?					
18. Note other operations of preparation of the soil, and cost of same.	Harrowed; $1	Harrowed; cost 50 cents.	Harrowing; 50 cents per acre.	Harrowing; $1	Plowed and harrowed.
19. Planting, date?	May 7	May 6	May 20		From 10th to 20th of May.
20. Method of—by hand or drill?	By hand	By hand	By hand	Drill	By drill.
21. Cost of planting?	$7.50 per acre	$1.50	$4 per acre	$1.50	$2.50.
22. Distance between the rows?	24 inches	3 feet	2 feet	26 inches	18 inches.
23. Distance between the roots?	8 inches	6 inches	6 or 8 inches	4 to 8 inches	10 to 12 inches.
24. Was stable manure applied to the crop?	Yes; cost $10	Yes	Yes; cost $30	Yes; $18	Yes; cost $50.
25. When, and in what quantity per acre?	About 5 cords per acre	6 cords per acre	In spring; 6 cords per acre	Spring; 6 cords per acre	10 cords per acre.
26. Was artificial manure applied?	No	No	No	Yes; $6	Yes.
27. When; how; what; how much; cost?		$6 per ½ acre		At planting	At second hoeing.
28. Time of first hoeing?		June 2		June 9	About June 1.
29. Done by hand or horse cultivator?	By hand	Horse	By hand	Hand	By hand and horse cultivator.
30. If special implement used, describe it					
31. Cost of first hoeing?	About $2	$1.50	$6 per acre	$5	About same as planting.
32. Area hoed by each laborer per day?	About ¼ acre	½ acre	¼ acre		About ⅛ of an acre.
33. Wages of laborers, by day or month?	$10 per month and board	$1 per day	50 cents per day	$1 per day	
34. Time and cost of second hoeing?	June 10; $2	June 16; $3 per acre	June 25; $3 per acre	July; $4	About July 1.
35. Date and cost of third hoeing?	July 1; $2	June 30; $2 per acre			Middle of July.
36. Date and cost of thinning?	July 10; $3.75	Hoed and thinned at same time.	July 8; $6 per acre	May 22; $11	Included in first hoeing.
37. How was thinning done; by hand, hoe, or special implement for the purpose?	By hand	Hand	By hoe	Hoe	Mostly by hand.
38. Time of harvesting?	Last of October	October 13	October 28	October 18 and 23	October 25.

39. Mode of pulling, by hand or with instrument?	By hand	Hand	By hand	Hand	With spade and hand.
40. Surface pulled by each man per day?		⅓ acre	¼ acre		About ⅓ of an acre.
41. Mode of removing leaves or tops; by hand or with knife?	With knife	Knife	Knife	Knife	With knife.
42. Quantity topped by each laborer per day?	2 tons	⅓ acre	5 tons per day		About 1 ton.
43. Total cost of harvesting per acre?	$10	$5	$4	$15	About $5.
44. Per ton of roots?	66 cents		$1		
45. Distance of crop from station, wharf, or factory?	50 miles from factory	2 miles from railroad	2 miles	Six miles	About 1 mile.
46. Cost of delivering?	75 cents per ton	50 cents per ton	$1 per ton		About 75 cents per ton.
47. Price received per ton of beets?	$6	$5 for 2,240 pounds	$5 for 2,240 pounds	$5	$6.
48. Are beets preserved in trenches?			Yes		By Maine Sugar Beet Co.
49. How long?					From 1 to 3 months.
50. Cost of preparing trenches?			$2		
51. Pulp, how obtained?					
52. Price of pulp at the factory?	$1 per ton	80 cents			$1 per ton.
53. Cost delivered on farm?	do	$2.30			About $1.75.
54. Estimated feeding value as compared with hay or corn fodder?					
55. Mode of preserving?					
56. Cost of same?					
57. Mode of feeding?					
58. To what animals fed?					
59. Quantity per day per head?					
60. What percentage of sugar in your beets?	10 per cent				About 5 to 6.
61. What is their average size and yield per acre?	6,060 pounds	18 tons	10 tons	13 tons per acre.	Yield, average 18 tons.
62. Place of beets in your rotation of crops?					
63. Cost of culture per acre:					
a. Of beets?	$56.50	$43.30	$71.80	$63 per acre	
b. Of corn?					
c. Of potatoes?					
64. Value of crops per acre:					
a. Of beets?	$90	$90	$50	$65 per acre	$108.
b. Of corn?					
c. Of potatoes?					
65. Average yield per acre:					
a. Of beets; tons?	15 tons	18 tons	10 tons	6½ tons per ¼ acre at $5 per ton.	18 tons.
b. Of corn; bushels?					
c. Of potatoes; bushels?					

CONDITION OF SUGAR-BEET CULTURE IN MAINE—Continued.

Number of entry	26	27	28	29	30
1. Kind of seed sown?	German sugar beet	Sugar beet seed	German beet seed	White sugar beet	Sugar beet seed.
2. Source of same?	Maine Beet Sugar Co	Maine Beet Sugar Co	Maine Beet Sugar Co	Maine Beet Sugar Co	Maine Beet Sugar Co.
3. Quantity sown per acre?	12 pounds	10 pounds	About 10 lbs. per acre	10 pounds	14 pounds.
3a. Cost of same?	$2.40	$2	$2	$2	$2 80.
4. Location of field, upland, or lowland?	Upland	Medium	Upland	Upland	Upland.
5. Is your soil sand, limestone, clay, slate, or loam?	Sand, clay loam	Clay loam	Clay and sandy loam	Loam	Loam.
6. Is it well drained?	Very well	Yes	Yes	Yes	Yes.
7. Is the drainage natural or artificial?	Natural	Natural	Natural	Natural	Natural.
8. Area planted in sugar beets?	1 acre	¾ of an acre	½ acre	2 acres	2 acres.
9. Crop on same land previous year?	Potatoes	Corn and beans	Potatoes and grass	Beets	Corn and potatoes.
10. Time of first plowing?	June, 1878	Fall	May 1	May	May 10.
11. Depth of same?	About 9 inches	8 inches	10 inches	1 foot	9 inches.
12. Cost of same, per acre?	$4			$3	$2.50.
13. Time of second plowing?	May 10				May 15.
14. Depth of same?	About 10 inches				9 inches.
15. Cost of same?	$3				$2.50.
16. Was subsoil plowing employed?	No	No	On part	No	No.
17. Depth of same?			12 inches		
18. Note other operations of preparation of the soil, and cost of same.	Harrowed and cultivated; $1.50.	Harrowed and furrowed	Harrowed several times	$1	Harrowed and cultivated; $3.
19. Planting, date?	May 10 to 15		Last of May	May 10 to 25	From May 20 to 25.
20. Method of—by hand or drill?	By hand	Drill	Drill	Norton's Seed Sower	Drill.
21. Cost of planting?	$2			$15	$5.
22. Distance between the rows?	24 inches	3½ feet	About 30 inches	22 inches	18 inches.
23. Distance between the roots?	8 inches	8 inches	From 3 to 8 inches	From 3 to 10 inches	8 inches.
24. Was stable manure applied to the crops?		Yes	Yes	Yes	Yes.
25. When, and in what quantity per acre?		10 cords per acre at time of planting.	In May	May 10 to 25; 10 cords per acre; cost $30.	5 cords; cost $25.
26. Was artificial manure applied?	Stockbridge fertilizer; 800 lbs. to acre; cost $20.	No	No	No	Stockbridge fertilizer.
27. When; how; what; how much; cost?	At time of planting; in drills.				4 bags per acre; $20.
28. Time of first hoeing?	About June 10		July 1	June 10	June 15.
29. Done by hand or horse cultivator?	By horse	Both	Both	Horse cultivator	Horse cultivator.
30. If special implement used, describe it		Common cultivator			
31. Cost of first hoeing?				$3	$3.
32. Area hoed by each laborer per day?	¼ of an acre			¼ of an acre	½ acre.
33. Wages of laborers, by day or month?	$1.25 per day	50 cts. per day and board		75 cents	By day, $1.25.
34. Time and cost of second hoeing?	June 25 to July 1; $4.75		August	June 20; 75 cts. per day.	July 5; $3 per acre.
35. Date and cost of third hoeing?	July 20, 75 cents			July 1 to 10; 75c. per day.	
36. Date and cost of thinning?	$2		Last of June; $5		July 10; $5 per acre.
37. How was thinning done; by hand, hoe, or special implement for the purpose?	By hand	By hand	By hand	By hand	By hand.
38. Time of harvesting?	October 10	October 15	October	October 15	October 30.

39. Mode of pulling, by hand or with instrument?	By hand	By hand	By hand	By hand	By hand.
40. Surface pulled by each man per day?	¼ of an acre			⅓ of an acre	½ of an acre.
41. Mode of removing leaves or tops; by hand or with knife?	Knife	Knife	Knife	Knife	With knife.
42. Quantity topped by each laborer per day?	1 ton			Topped when pulled	3 tons.
43. Total cost of harvesting per acre?	$8			$15	$15.
44. Per ton of roots?	$2				
45. Distance of crop from station, wharf, or factory?	3 miles	5 miles	5 miles from station	¾ of an acre	30 miles from factory.
46. Cost of delivering?	$1.50 per ton	$1.50 per ton	$1.50 per ton	$6	$1 per ton.
47. Price received per ton of beets?	$5	$5	$5	$4	$6 per 2,240 pounds.
48. Are beets preserved in trenches?			No	No	
49. How long?					
50. Cost of preparing trenches?					
51. Pulp, how obtained?					
52. Price of pulp at the factory?					$1 per ton.
53. Cost delivered on farm?					
54. Estimated feeding value as compared with hay or corn fodder?					
55. Mode of preserving?					
56. Cost of same?					
57. Mode of feeding?					
58. To what animals fed?					
59. Quantity per day per head?					
60. What percentage of sugar in your beets?				10 per cent	
61. What is their average size and yield per acre?					32 tons per acre.
62. Place of beets in your rotation of crops?					
63. Cost of culture per acre:					
a. Of beets?	$54.40			$90.50	$118.80.
b. Of corn?	$40				
c. Of potatoes?	$45				
64. Value of crops per acre:					
a. Of beets?	$20	$50	$50	$120	$192.
b. Of corn?	$36				
c. Of potatoes?	$75				
65. Average yield per acre:					
a. Of beets; tons?	4 tons	10 tons	10 tons	20 tons	32 tons
b. Of corn; bushels?	60 bushels				
c. Of potatoes; bushels?	150 bushels				

CONDITION OF SUGAR-BEET CULTURE IN MAINE—Continued.

Number of entry	31	32	33	34	35
1. Kind of seed sown?		Red beet		Sugar beet seed	
2. Source of same?	Beet Sugar Company	Maine Beet Sugar Co	Germany	Maine Beet Sugar Co	Maine Beet Sugar Co.
3. Quantity sown per acre?	6 pounds	8 pounds	2½ pounds	14 pounds per acre	10 pounds.
3a. Cost of same?	$1.20	$1.60	50 cents	$2.80	$2.
4. Location of field, upland, or lowland?	Medium	Upland	Upland	Upland	Lowland.
5. Is your soil sand, limestone, clay, slate, or loam?	Sand	Loam	Clay	Loam	Loam.
6. Is it well drained?	Yes	Yes	No	Yes	Yes.
7. Is the drainage natural or artificial?	Natural.	Natural		Natural	Natural.
8. Area planted in sugar beets?	½ acre	¾ acre	1 acre	1 acre	½ acre.
9. Crop on same land previous year?	Corn	Turnips and beets	Beans	Corn	Corn.
10. Time of first plowing?	November, 1878	May 15	November	May 1, 1879	May 10.
11. Depth of same?	6 inches	8 inches	7 inches	13 inches	10 inches.
12. Cost of same, per acre?	$2.	$4	$3	$4	$3.
13. Time of second plowing?	May, 1879			Plowed but once	
14. Depth of same?	10 inches				6 inches.
15. Cost of same?	$2				$1.50.
16. Was subsoil plowing employed?	No	No	No		No.
17. Depth of same?					
18. Note other operations of preparation of the soil, and cost of same.	Harrowing, 50 cents		Pulverizing and harrowing, $2.	Harrowed and pulverized	Harrowing, $1 per acre.
19. Planting, date?	June 10	May 20	May 10	May 12	May 19.
20. Method of—by hand or drill?	Hand	By hand	Drill	By hand	Hand.
21. Cost of planting?	$2	$7	$1	$3	$5.
22. Distance between the rows?	3½ feet	20 to 24 inches	2 feet	20 inches	2 feet.
23. Distance between the roots?	6 to 8 inches	6 to 10 inches	6 inches	8 inches	8 inches.
24. Was stable manure applied to the crop?	No		Yes; cost $2 per cord	Yes	Yes.
25. When, and in what quantity per acre?			Spring, about 15 cords	When plowed; 20 cords per acre; cost $30.	May 10, 12 cords per acre; cost $2 per cord.
26. Was artificial manure applied?	Yes		Yes	No	No.
27. When; how; what; how much; cost?	June 10, 50 pounds, $1.12		2 bags phosphate, $10		
28. Time of first hoeing?	July 1	June 1	May 25	June 16	June 18.
29. Done by hand or horse cultivator?	Horse	By hand	Hand cultivator	By hand	By hand.
30. If special implement used, describe it					
31. Cost of first hoeing?	$1.50	$6	$4	$5	$10 per acre.
32. Area hoed by each laborer per day?	¼ of an acre		¼	¼ of an acre	
33. Wages of laborers, by day or month?	75 cents per day		$15 per month	$1.25 day	
34. Time and cost of second hoeing?	August, $2.25	June 30, $6	June 2, $4	June 30, $5	July 2, $8 per acre.
35. Date and cost of third hoeing?		August 10, $6	do $4		
36. Date and cost of thinning?			June 15, $4	June 30, $5	
37. How was thinning done; by hand, hoe, or special implement for the purpose?	Hand	By hand	Hand hoe	Hand and hoe	Hand hoe.
38. Time of harvesting?	October	October 10 to 15	October 10	October 9	October 10.
39. Mode of pulling, by hand or with instrument?	Hand	By hand	Common hoe	Hand	Hand.

40. Surface pulled by each man per day?	¼ of an acre		½ of an acre	¼ of an acre	
41. Mode of removing leaves or tops; by hand or with knife?	Knife	Knife		Knife	Knife.
42. Quantity topped by each laborer per day?	⅛ of an acre			1 ton	2 tons.
43. Total cost of harvesting per acre?	$2	$16	$5	$6	
44. Per ton of roots?	$1			5 tons	
45. Distance of crop from station, wharf, or factory?	½ mile	1½ miles	1 mile	2½ miles from station	3 miles.
46. Cost of delivering?	$3	$8		50 cents per ton	75 cents per ton.
47. Price received per ton of beets?	$5	$5	$5 for 2,240 pounds	$5 per ton	$5.
48. Are beets preserved in trenches?	No		No	Yes	No.
49. How long?				From 7 to 8 months	
50. Cost of preparing trenches?				25 cents per ton	
51. Pulp, how obtained?					
52. Price of pulp at the factory?	$1.80			$1 per ton	
53. Cost delivered on farm?				$2.50 per ton	
54. Estimated feeding value as compared with hay or corn fodder?				Not one-tenth value of hay or corn.	
55. Mode of preserving?				None sure	
56. Cost of same?					
57. Mode of feeding?					
58. To what animals fed?				Hogs mostly	
59. Quantity per day per head?				2 pecks, with 3 quarts corn meal.	
60. What percentage of sugar in your beets?			10 per cent		
61. What is their average size and yield per acre?		16 tons	7½ tons	2 pounds; 5 tons per acre	Yield 11 tons.
62. Place of beets in your rotation of crops?					
63. Cost of culture per acre:					
a. Of beets?		$54.60	$67.50	$70.80	$76.50.
b. Of corn?			$42.25	$49	$25.
c. Of potatoes?			$27.50	$40	$15.
64. Value of crops per acre:					
a. Of beets?		$80	$37.50	$25	$55.
b. Of corn?			$45	$30	
c. Of potatoes?			$50	$40	
65. Average yield per acre:					
a. Of beets; tons?		16 tons	7½ tons	5 tons	11 tons.
b. Of corn; bushels?					
c. Of potatoes; bushels?					150 bushels.

CONDITION OF SUGAR-BEET CULTURE IN MAINE—Continued.

Number of entry	36	37	38	39	40
1. Kind of seed sown?	White sugar beet			German sugar beet	German sugar beet.
2. Source of same?			Germany	Portland Beet Sugar Co	Maine Beet Sugar Co.
3. Quantity sown per acre?	10 pounds	5½ pounds	7½ pounds	10 pounds	14 pounds.
3a. Cost of same?	$2		$1.50	$2	$2.80.
4. Location of field, upland or lowland?	Upland	Upland	Upland	Upland	Upland.
5. Is your soil sand, limestone, clay, slate, or loam?	Loam	Light loam	Clay loam	Gravel loam	Clay loam.
6. Is it well drained?	Yes		Yes	Yes	No.
7. Is the drainage natural or artificial?	Natural		Natural	Natural	Natural.
8. Area planted in sugar beets?	¾ acre	½ acre	½ acre	½ acre	1 acre.
9. Crop on same land last year?	Potatoes	Corn	Light hay crop	Sweet corn	Potatoes.
10. Time of first plowing?	May 10, 1879	May 20	Fall	Middle of May	April 1.
11. Depth of same?	8 inches	12 inches	6 inches	8 inches	10 inches.
12. Cost of same, per acre?	75 cents	$2 per acre	$3	$3	½ day with team, $2.
13. Time of second plowing?	May 19			Plowed but once	April 20.
14. Depth of same?	4 inches				
15. Cost of same?	75 cents				$2.
16. Was subsoil plowing employed?	No			No	No.
17. Depth of same?			Manured in furrows; $2 per acre.		
18. Note other operations of preparation of the soil, and cost of same.	Well harrowed	Harrowed	Harrowed once, $1 per acre.		Harrowing, $1.
19. Planting, date?	May 21		Last of May	About May 20	April 29.
20. Method of—by hand or drill?	Hand	Hand in drill	Hand	By drill	Drill.
21. Cost of planting?	$2	$2.50	$2		$1.
22. Distance between the rows?	2 feet	18 inches	2 feet	28 inches	2 feet.
23. Distance between the roots?	8 inches	8 inches	6 inches	6 inches	8 to 10 inches.
24. Was stable manure applied to the crops?	Yes	Yes	Barn-yard manure	Yes; $15	Yes; $36.
25. When, and in what quantity per acre?	May 19, 6 cords; $30	2 cords to ½ acre	Last of May, 8 cords	In drills, rate of 5 cords	12 cords before planting.
26. Was artificial manure applied?	Yes		Phos. lime, 100 lbs. p. a	Yes	None.
27. When; how; what; how much; cost?	May 21; drills; Stockbridge fertilizer; $10.		Last of May, $2.50	Stockbridge fertilizer, $10 per acre at plant'g.	
28. Time of first hoeing?	June 9	June 20	June 20	June 20	May 10 to 20.
29. Done by hand or horse cultivator?	Hand	Cultivator and hoe	By hand	Used both	Both.
30. If special implement used, describe it					
31. Cost of first hoeing?	$2	$2.50	$1.50		$10.
32. Area hoed by each laborer per day?	½ acre		½ acre		⅒ acre.
33. Wages of laborers, by day or month?			$13 per month		
34. Time and cost of second hoeing?	June 27; $3	$2 per ½ acre	Aug. 1, $6 per acre		June 15, $8.
35. Date and cost of third hoeing?				June 25	July 24, $4.
36. Date and cost of thinning?	July 2; $5		Last of June, $1.50 per a.		
37. How was thinning done; by hand, hoe, or special implement for the purpose?	Hand and hoe	By hand	By hand	By hand	By hand.
38. Time of harvesting?	October	October	Middle of October	October 5	15 to 30 of October.

39. Mode of pulling, by hand or with instrument?	Hand	By hand	By hand	By hand	By hand.
40. Surface pulled by each man per day?	¼ acre		½ acre per day		¼ acre.
41. Mode of removing leaves or tops; by hand or with knife?	Knife	Knife	By hand	Knife	Hand and knife.
42. Quantity topped by each laborer per day?	⅛ acre		⅓ acre		$\frac{1}{20}$ acre.
43. Total cost of harvesting per acre?	$12		$3		$8.
44. Per ton of roots?					
45. Distance of crop from station, wharf, or factory?	5 miles	2½ miles	5 miles	3½ miles to railroad station.	2 miles from railroad station.
46. Cost of delivering?	$15	$1 per ton	$1 per ton		$10.
47. Price received per ton of beets?	$5	$5 per ton	$5 per ton	$5	$5.
48. Are beets preserved in trenches?	No			Yes	Yes.
49. How long?					Until after Dec. 10.
50. Cost of preparing trenches?					
51. Pulp, how obtained?					
52. Price of pulp at the factory?					
53. Cost delivered on farm?					
54. Estimated feeding value as compared with hay or corn fodder?					
55. Mode of preserving?					
56. Cost of same?					
57. Mode of feeding?					
58. To what animals fed?					
59. Quantity per acre per head?					
60. What percentage of sugar in your beets?					
61. What is their average size and yield per acre?	Yield, 17 tons per acre		1 pound; 14 tons per acre.	12 tons per acre	Weight from 2 to 10 lbs; yield, 22 tons per acre.
62. Place of beets in your rotation of crops?			First	After corn	Third.
63. Cost of culture per acre:					
a. Of beets?	$82.50		$70		$84.80.
b. Of corn?	$44.25		$45.50		
c. Of potatoes?	$42.25		$45.50		
64. Value of crops per acre:					
a. Of beets?	$85		$70	$60	$110.
b. Of corn?	$50		$40		
c. Of potatoes?			$40		
65. Average yield per acre:					
a. Of beets; tons?	17 tons		14 tons	12 tons	22 tons per acre.
b. Of corn; bushels?					
c. Of potatoes; bushels?	200 bushels				

CONDITION OF SUGAR-BEET CULTURE IN MAINE—Continued.

Number of entry	41	42	43	44	45
1. Kind of seed sown?	Sugar beet	White sugar-beet seed		Maine Sugar Beet Co	Imperial sugar beet.
2. Source of same?			Maine Beet Sugar Co	Maine Beet Sugar Co	Maine Beet Sugar Co.
3. Quantity sown per acre?	7 pounds	12 pounds		14 pounds	7 pounds.
3a. Cost of same?	$1.40	$2.40		$2.80	$1.40.
4. Location of field—upland or lowland?	Upland		Upland	Upland	Lowland.
5. Is your soil sand, limestone, clay, slate, or loam?	Sandy loam; new land	Heavy loam land	Loam	Gravelly loam	Clay.
6. Is it well drained?	Yes	Yes	Yes	Yes	Yes.
7. Is the drainage natural or artificial?	Natural	Natural	Natural	Natural	By plowing.
8. Area planted in sugar beets?		¾ acre	½ acre	¼ of an acre	½ acre.
9. Crop on same land previous year?		Sweet corn	Yellow globe beets	Sod land	Potatoes.
10. Time of first plowing?	May 5	1st of May	9th of May	October	October, 1878.
11. Depth of same?	8 inches	12 inches	6 inches	8 inches	8 inches.
12. Cost of same, per acre?	$4	$5		$4	$4.
13. Time of second plowing?					Plowed but once.
14. Depth of same?					
15. Cost of same?					
16. Was subsoil plowing employed?	No	No	No	No	No.
17. Depth of same?					
18. Note other operations of preparation of the soil, and cost of same.			Harrowed	Harrowed and furrowed	Harrowing, 50 cents.
19. Planting, date?	Last of May	10th and 12th of May	May 10	May 15	1st of June.
20. Method of—by hand or drill?	Drill	Drill	By hand	Hand	By hand.
21. Cost of planting?	$5	$4	About $1	$2 for ¼ acre	$2.
22. Distance between the rows?	14 inches	3½ feet	20 inches	24 and 12 in., double row	30 inches.
23. Distance between the roots?	8 inches	6 to 8 inches	8 to 10 inches	8 inches	Not uniform.
24. Was stable manure applied to the crops?	Yes	Barnyard manure	Yes	Yes	Yes.
25. When, and in what quantity per acre?		About 8 cords	In the spring	12 loads spread, 11 loads in furrows.	Just before planting, 5 cords; cost $15.
26. Was artificial manure applied?	No	No		No	No.
27. When; how; what; how much; cost?					
28. Time of first sowing?	Last of June	About May 20	1st of June	June 5	Last of June.
29. Done by hand or horse cultivator?	By hand	By hand	By hand	Hand	By hand.
30. If special implement used, describe it.					
31. Cost of first hoeing?	$5	$12		$4	$2.
32. Area hoed by each laborer per day?	⅛ acre				¼ acre.
33. Wages of laborers, by day or month?		$33 a month or $1.25 a day		$12 per month	$15.
34. Time and cost of second hoeing?		$6	Middle of June	July	Last of July.
35. Date and cost of third hoeing?					
36. Date and cost of thinning?					
37. How was thinning done; by hand, hoe, or special implement for the purpose?	By hand	By hand	By hand	Hand	By hand.
38. Time of harvesting?	October 20	About October 10	October 3	October 15	Last of October.
39. Mode of pulling, by hand or with instrument?	By hand	By hand	By hand	By hand	By hand.

40. Surface pulled by each man per day?	¼ acre			7 square rods	¼ acre.
41. Mode of removing leaves or tops; by hand or with knife?	By hand	Knife	Knife	Knife	Knife.
42. Quantity topped by each laborer pay day?				About 1 ton	2 tons.
43. Total cost of harvesting per acre?	$4			$15	$12.
44. Per ton of roots?					
45. Distance of crop from station, wharf, or factory?	2½ miles from railroad	12 miles	2½ miles from railroad	22 miles to factory	4 miles to railroad, 16 from factory.
46. Cost of delivering?	50 cents per ton	$1.50 per ton		Deliv. by water, 60c. a ton	$1 per ton to station, $2 to factory.
47. Price received per ton of beets?	$5	$6	$5 per ton of 2,240 lbs.	$6	$5 per ton.
48. Are beets preserved in trenches?	Yes			Yes	
49. How long?	Three or four months			All winter	
50. Cost of preparing trenches?					
51. Pulp, how obtained?					
52. Price of pulp at the factory?				$1	
53. Cost delivered on farm?					$2.
54. Estimated feeding value as compared with hay or corn fodder?					
55. Mode of preserving?					
56. Cost of same?					
57. Mode of feeding?					
58. To what animals fed?					
59. Quantity per day per head?					
60. What percentage of sugar in your beets?				10 to 15 per cent	
61. What is their average size and yield per acre?	From 3 to 5 in. through		20 tons	Yield, 20 tons; 1 pound	2 to 6 pounds.
62. Place of beets in your rotation of crops?				Second	
63. Cost of culture per acre:					
a. Of beets?	$21.90			$45.80†	$99.90.
b. Of corn?					
c. Of potatoes?					
64. Value of crops per acre:					
a. Of beets?	$75		$100	$120	$160.
b. Of corn?					
c. Of potatoes?					
65. Average yield per acre:					
a. Of beets; tons?	15 tons				$32.
b. Of corn; bushels?					
c. Of potatoes; bushels?					

†Manure not included.

CONDITION OF SUGAR-BEET CULTURE OF MAINE—Continued.

Number of entry	46	47	48	49	50
1. Kind of seed sown?	German sugar beet	Sugar beet			Sugar beet.
2. Source of same?		Maine Beet Sugar Co	Maine Beet Sugar Co	Maine Sugar Beet Co	Maine Beet Sugar Co.
3. Quantity sown per acre?	7 pounds	7 pounds	About 8 pounds	12 pounds	10 pounds.
3a. Cost of same?		$2.80	$1.60	$2.80	$2.
4. Location of field, upland or lowland?	Upland	Lowland	Upland	Upland	Upland.
5. Is your soil sand, limestone, clay, slate, or loam?	Clay loam	Loam	Loam	Stone loam	Clay and sand loam.
6. Is it well drained?	Yes	Not very	Yes	Very well	Yes.
7. Is the drainage natural or artificial?	Natural	Artificial	Natural	Natural	Natural.
8. Area planted in sugar beets?	¾ acre	½ acre	½ acre	½ acre	From ½ to 2 acres.
9. Crops on same land previous year?	Corn	Beets		Corn	Corn.
10. Time of first plowing?	Middle of May	Early in spring		May 15	
11. Depth of same?	8 inches	5 inches	8 inches	8 inches	8 inches.
12. Cost of same, per acre?		$3.50	$4	$1.50	$5.
13. Time of second plowing?					
14. Depth of same?		About 5 inches			
15. Cost of same?			$2		$2.
16. Was subsoil plowing employed?		No	No	No	No.
17. Depth of same?					
18. Note other operations of preparation of the soil, and cost of same?		$5		Harrowed	Harrowed; $1.50.
19. Planting, date?		About the middle of June	Middle of May		May 15.
20. Method of—by hand or drill?		By hand		Hand drill	By hand.
21. Cost of planting?		$4.50	$6	$4	$5.
22. Distance between the rows?		2½ feet	About 3 feet	30 inches	2½ feet.
23. Distance between the roots?		8 inches	About 8 inches	4 to 10 inches	3 to 6 inches.
24. Was stable manure applied to the crops?		Yes; cost $20	Stable manure; cost $32	Yes	Yes; cost $20.
25. When, and in what quantity per acre?		Early spring; 10 cords	About 8 cords	2 cords	
26. Was artificial manure applied?		No	No	Yes	Partly; $20.
27. When; how; what; how much; cost?				At planting; 1½ bags; $7.50.	After planting; Stockbridge fertilizer; 800 pounds per acre.
28. Time of first hoeing?		$2.25	When 4 or 5 inches high	June 26 to July 6	July 1 to August 1.
29. Done by hand or horse cultivator?		By hand	Hand	Horse and hand	Hand.
30. If special implement used, describe it?					
31. Cost of first hoeing?			$6, thinning included	$8	$8.
32. Area hoed by each laborer per day?			⅛ of an acre		⅛ acre.
33. Wages of laborers, by day or month?			$1 per day		$1 per day.
34. Time and cost of second hoeing?			Two days; $2	$1.50	August 1; $8.
35. Date and cost of third hoeing?					
36. Date and cost of thinning?				$6	
37. How was thinning done; by hand, hoe, or special implement for the purpose?		By hand	By hand	By hand	Hoe and hand.
38. Time of harvesting?		Middle of October	About October 20	October 25	October 15 to 25.

39. Mode of pulling; by hand or with instrument?		By hand	By hand	By hand	By hand.
40. Surface pulled by each man per day?			About ⅛ of an acre	⅜ acre	1/10 acre.
41. Mode of removing leaves or tops; by hand or with knife?			Knife	Knife	
42. Quantity topped by each laborer per day?			¼ of an acre	⅓ acre	
43. Total cost of harvesting per acre?		$9	$8	$5.68	$16.
44. Per ton of roots?			$1	50 cents	
45. Distance of crop from station, wharf, or factory?		2½ miles from station	1 mile	6 miles	3 miles.
46. Cost of delivering?		$1.50 per acre	$10	$1.50 per ton	75 cents per ton.
47. Price received per ton of beets?		$5	$5	$5	$5.
48. Are beets preserved in trenches?		No			
49. How long?					
50. Cost of preparing trenches?					
51. Pulp, how obtained?					
52. Price of pulp at the factory?					
53. Cost delivered on farm?					$2.75.
54. Estimated feeding value as compared with hay or corn-fodder?					
55. Mode of preserving?					
56. Cost of same?					
57. Mode of feeding					
58. To what animals fed?					
59. Quantity per day or head					
60. What percentage of sugar in your beets?					
61. What is their average size and yield per acre?		1 pound; 4 tons per acre.	14 tons per acre	½ to ¾ pound	½ to 8 pounds.
62. Place of beets in your rotation of crop?					
63. Cost of culture per acre:					
a. Of beets?		$48.55	$71.60	$61.68 (his estimate)	$98.75.
b. Of corn?		$27.75	$53	$22 (his estimate)	
c. Of potatoes?		$23.75	$53	$21 (his estimate)	
64. Value of crops per acre:					
a. Of beets?		$20	$70	$70 (his estimate)	$75.
b. Of corn?					
c. Of potatoes?					
65. Average yield per acre:					
a. Of beets; tons?		4 tons	14 tons	14 tons	15 tons.
b. Of corn; bushels?		40 bushels	50 bushels	35 bushels	60 bushels.
c. Of potatoes; bushels?		100 bushels	200 bushels	125 bushels	150 bushels.

CONDITION OF SUGAR-BEET CULTURE IN MAINE—Continued.

Number of entry	51	52	53	54	55
1. Kind of seed sown?	Sugar-beet seed	Sugar beet	French sugar beet	Sugar-beet seed	Sugar beet.
2. Source of same?	Maine Beet Sugar Co	Maine Beet Sugar Co	Maine Beet Sugar Co	Maine Beet Sugar Co	Germany.
3. Quantity sown per acre?	14 pounds	14 pounds	7 pounds	10 pounds	8 pounds.
3a. Cost of same?	$2.80	$2.80	$1.40	$2	$1.60.
4. Location of field, upland or lowland?	Upland	Lowland	Upland	Upland	Upland.
5. Is your soil sand, limestone, clay, slate, or loam?	Loam	Clay	Clay loam	Clay loam	Slaty loam.
6. Is it well drained?	Yes	Yes	Yes	Yes	Yes.
7. Is the drainage natural or artificial?	Natural	Artificial	Natural	Natural	Natural.
8. Area planted in sugar beets?	½ acre	¼ of an acre	½ acre	½ acre	½ acre.
9. Crop on same land previous year?	Corn	Beets for stock	Potatoes	Oats	Beets and carrots.
10. Time of first plowing?	Last of October, 1878	May 1	May 18		May 1.
11. Depth of same?	6 inches	From 8 to 10 inches	9 inches	8 inches	8 to 10 inches.
12. Cost of same, per acre?	$2	$3	$1.50	$2	$3.
13. Time of second plowing?	May 1, 1879	Middle of May	May 20	Only one plowing	
14. Depth of same?	8 inches	5 or 6 inches	9 inches		
15. Cost of same?	$2	$3 per acre	$1.25		
16. Was subsoil plowing employed	No	No	No	No	No.
17. Depth of same?					
18. Note other operations of preparation of the soil, and cost of the same.	Harrowing and hauling, $3.	Harrowing and rolling; $2 per acre.	Harrowing; $1	Harrowing; 50 cents	$1.
19. Planting date?	May 12	Middle of May	May 24 and 25	May 15	May 19.
20. Method of—by hand or drill?	Hand	Hand	By hand	Drill	Drill.
21. Cost of planting?	$2	$10 per acre	$2	$1.50	50 cents.
22. Distance between the rows?	2 feet	2 feet	20 inches	16 inches	2½ feet.
23. Distance between the roots?	6 to 8 inches	From 6 to 8 inches	8 inches	8 inches	8 inches.
24. Was stable manure applied to the crops?	Yes	Yes	Yes; cost $30	Barn-yard manure; $12	Yes.
25. When, and in what quantity per acre?	4 cords; $16	At first plowing; 6 cords per acre. $24.	Before first plowing; at rate of 10 cords per acre.	Before planting; 4 cords.	In spring; 8 cords. $32.
26. Was artificial manure applied?	Yes	Yes	Yes	Yes; Peruvian guano	Yes.
27. When; how; what; how much; cost?	Planting in drill; phosphate; $10.75.	Bradley's; 1,000 pounds per acre.	Stockbridge's; 200 lbs; $5.	Before planting; $5	Stockbridge's; 400 lbs. $10.
28. Time of first hoeing?	June 1	Middle of June	About June 10	June 6	June 1.
29. Done by hand or horse cultivator?	Hand	By hand	By hand	Hand	Hand.
30. If special implement used, describe it?			Hoe		
31. Cost of first hoeing?	$2	$3.75	$3	$6	$6.
32. Area hoed by each laborer per day?	½ acre		⅛ of an acre		
33. Wages of laborers, by day or month?	75 cents per day and board.	75 cents per day		$1 per day	$16.
34. Time and cost of second hoeing?	June 20; $6	Middle of July; $2.25	July 1; $3	$8	
35. Date and cost of third hoeing?	August 1; $1		July 24; $2	July 15	
36. Date and cost of thinning			Included in hoeing		June 16; $6.
37. How was thinning done; by hand, hoe, or special implement for the purpose?	Hand	By hand	By hand	By hand	Hand.
38. Time of harvesting?	October 24 and 25	Middle of October	After October 20	October 9	October 16 to 19.

39. Mode of pulling, by hand or with instrument?	Hand	By hand	By hand	By hand	Hand.
40. Surface pulled by each man per day?	⅓ acre	¼ of an acre	¼ of an acre	⅓ per day	⅓ of an acre.
41. Mode of removing leaves or tops; by hand or with knife?	Knife	Knife	Knife		Knife.
42. Quantity topped by each laborer per day?	4 tons	⅛ of an acre	About 3⅜ tons per day		2 tons.
43. Total cost of harvesting per acre?	$6	$12; loaded on wagon	$8 per acre	$4	$15.
44. Per ton of roots?					$1.75.
45. Distance of crop from station, wharf, or factory?	1 mile	2½ miles from railroad	2 miles	½ mile	2½ miles.
46. Cost of delivering?	$3 per acre	80 cents per ton	About 75 cents per ton	$4 per acre	
47. Price received per ton of beets?	$5	$5	$5	$5	$5.
48. Are beets preserved in trenches?				Yes	No.
49. How long?				4 months	
50. Cost of preparing trenches?					
51. Pulp, how obtained?					
52. Price of pulp at the factory?					80 cents.
53. Cost, delivered on farm?					$2.80.
54. Estimated feeding value as compared with hay or corn-fodder?					
55. Mode of preserving?					
56. Cost of same?					
57. Mode of feeding?					
58. To what animals fed?					
59. Quantity per day per head?					
60. What percentage of sugar in your beets?					
61. What is their average size and yield per acre?	1½ pounds; yield 16 tons.	20 tons per acre	15 tons per acre	Size, 6 inches; yield, 20 tons.	12 tons per acre.
62. Place of beets in your rotation of crops?	First	First			
63. Cost of culture per acre:					
a. Of beets?	$49.55	$98.80	$68.40	$45	$75.10.
b. Of corn?	$51.50			$51.48	
c. Of potatoes?	$51			$42.50	
64. Value of crops per acre:					
a. Of beets?	$80	$100	$75.00	$100	$60.
b. Of corn?	$50				$54.
c. Of potatoes?	$50				$50.
65. Average yield per acre:					
a. Of beets; tons?	16 tons	20 tons	15 tons	20 tons	12 tons.
b. Of corn; bushels?					
c. Of potatoes; bushels?					

CONDITION OF SUGAR-BEET CULTURE IN MAINE—Continued.

Number of entry	56	57	58	59	60
1. Kind of seed sown?	White sugar beet	German sugar beet	Sugar beet	Lane's improved sugar beet.	Sugar beet.
2. Source of same?	Maine Beet Sugar Co.	Maine Beet Sugar Co.	Germany	Maine Beet Sugar Co.	Maine Beet Sugar Co.
3. Quantity sown per acre?	About 10 pounds	11 pounds	7 pounds	11 pounds	6 pounds.
3a. Cost of same?	$2	$2.20	$1.40	$2.20	$1.60.
4. Location of field, upland or lowland?	Upland	Upland	Upland	Upland	Upland.
5. Is your soil sand, limestone, clay, slate, or loam?	Gravelly loam	Clay loam	Clay loam	Sandy loam	Sandy loam.
6. Is it well drained?	Yes	Yes	Yes	Yes	Yes.
7. Is the drainage natural or artificial?	Natural	Natural	Natural	Natural	Natural.
8. Area planted in sugar beets?	½ acre	2 acres		1 acre	¼ of an acre.
9. Crop on same land previous year?	Sweet corn and turnips.	Potatoes, corn, and grass.	Corn and potatoes	Hay	Potatoes.
10. Time of first plowing?	May 7	May	May 1	July, 1878	
11. Depth of same?	8 inches	9 inches	10 inches	8 inches	6 inches.
12. Cost of same per acre?	$3	$4	$7, including subsoil	$4	$5.
13. Time of second plowing?	May 9	May	May 8	May 19, 1879	Fall.
14. Depth of same?	8 inches	9 inches	6 inches		5 inches.
15. Cost of same?	$3	$3	$2	$3	$3.
16. Was subsoil plowing employed?	No	No	Yes		
17. Depth of same?			4 inches		
18. Note other operations of preparation of the soil, and cost of same.		Harrowing; $2	Harrowed 4 times; $4		$1.
19. Planting, date?	May 13	20th to 30th of May	May 10	May 24, 1879	May 15.
20. Method of—by hand or drill?	Drill	Drill	Hand	Drill	By hand.
21. Cost of planting?	50 cents	$6 per acre	$4	$6	$25. (?)
22. Distance between the rows?	14 inches	30 inches	12 and 30 inches	24 inches	2 feet.
23. Distance between the roots?	8 inches	8 to 10 inches	8 inches	6 to 8 inches	8 inches.
24. Was stable manure applied to the crops?	Yes; 3 cords; broadcast.	Yes	Yes; 12 cords; $84	Yes; cost $18	Yes.
25. When, and in what quantity per acre?	Before plowing; $9	Before harrowing; 6 cords. $24.	After first and second plowing.	6 cords	May 20; 20 cords
26. Was artificial manure applied?	Yes; Bradley's superphosphate.	Yes; Stockbridge fertilizer.	No	Yes; at planting	No.
27. When; how; what; how much; cost?	200 pounds; cost, $4.25	600 pounds per acre; $15.		Phosphate of lime; $7.50.	
28. Time of first hoeing?	May 30	June 15 to 20	Last of May		June 20.
29. Done by hand or horse cultivator?	By hand.	Both	Both	Hand	By hand.
30. If special implement used, describe it		Horse hoe and cultivator			
31. Cost of first hoeing?	About 75 cents	$2.50 per acre	$3		$5.
32. Area hoed by each laborer per day?	½ acre per day				
33. Wages of laborers, by day or month?	$16 per month				$1 per day.
34. Time and cost of second hoeing?	Finished June 14; $6		June; $5		July 10; $5.
35. Date and cost of third hoeing?	July 5; $3		July; $5		
36. Date and cost of thinning?		20th of June to July 10; $6 per acre.	June; $5		
37. How was thinning done; by hand, hoe, or special implement for the purpose?	By hand	By hand	Hand and hoe	Hand	By hand.

38. Time of harvesting?	October 6, 7, 8	October 25	October	Last of October	October 15.
39. Mode of pulling, by hand or with instrument?	By hand	By hand	Hand	Hand	By hand.
40. Surface pulled by each man per day?	$\frac{1}{10}$ of an acre	$\frac{1}{4}$ of an acre	$\frac{1}{4}$ of an acre		
41. Mode of removing leaves or tops, by hand or with knife?	By hand	Knife		Knife	Knife.
42. Quantity topped by each laborer per day?	Topped as pulled	1 ton	$2\frac{1}{3}$ tons		
43. Total cost of harvesting per acre?	$10 per acre	$12 per acre	$10 per acre		$16.
44. Per ton of roots?			50 cents		
45. Distance of crop from station, wharf, or factory?	One mile	$3\frac{1}{2}$ miles from station	4 miles	2 miles	3 miles from station.
46. Cost of delivering?	$3 per acre	75 cents per ton	$1.25 per ton		$2 per ton.
47. Price received per ton of beets?	$5 per ton	$5	$5	$5	$5.
48. Are beets preserved in trenches?				No	
49. How long?					
50. Cost of preparing trenches?					
51. Pulp, how obtained?					
52. Price of pulp at the factory?					
53. Cost delivered on farm?	$1.50				
54. Estimated feeding value as compared with hay or corn-fodder?					
55. Mode of preserving?					
56. Cost of same?					
57. Mode of feeding?					
58. To what animals fed?					
59. Quantity per day per head?					
60. What percentage of sugar in your beets?	11 to 12 per cent.				
61. What is their average size and yield per acre?	$\frac{3}{4}$ of a pound; 15 tons per acre.	1 pound; yield, 10 tons per acre.		$12\frac{1}{2}$ tons per acre	1 pound; 16 tons.
62. Place of beets in your rotation of crops?					
63. Cost of culture per acre:					
a. Of beets?	$44.50	$84.20	$142.90	$40.70 (not complete)	$93.60.*
b. Of corn?	$38	$30	$50.75		$22.
c. Of potatoes?	$31	$20	$57.50		$22.
64. Value of crops per acre:					
a. Of beets?	$75	$50	$90	$62.50	$80.
b. Of corn?	$36.25				
c. Of potatoes?	$31.50				
65. Average yield per acre:					
a. Of beets; tons?	15 tons	10 tons per acre	18 tons	$12\frac{1}{2}$ tons	16 tons.
b. Of corn; bushels?	35 bushels				25 bushels.
c. Of potatoes; bushels?	70 bushels				50 bushels.

* Stable manure not included.

CONDITION OF SUGAR-BEET CULTURE IN MAINE—Continued.

Number of entry	61	62	63	64	65
1. Kind of seed sown?	Silesian	Silesian			White sugar beet.
2. Source of same?	Germany	Maine Beet Sugar Co	Maine Beet Sugar Co	Maine Beet Sugar Co	Maine Beet Sugar Co.
3. Quantity sown per acre	10 to 12 pounds	14 pounds	7 pounds	7 pounds	About 12 pounds.
3a. Cost of same?	$2.40	$2.80	$1.40	$1.40	$2.40.
4. Location of field, upland or lowland?	Lowland	Medium	Upland	Upland	Upland.
5. Is your soil sand, limestone, clay, slate, or loam?	Loam	Clay loam	Clay loam	Loam	Loam.
6. Is it well drained?	Yes	Yes	Yes	Yes	Yes.
7. Is the drainage natural or artificial?	Natural.	Natural	Natural	Natural	Natural.
8. Area planted in sugar beets?	3 acres	½ acre	1 acre	½ acre	½ acre.
9. Crop on same land previous years?	Sugar beets.	Corn	Potatoes	Corn	Corn and grass.
10. Time of first plowing?	Early in April	May, 1878	May 7	Early spring	Fall and spring.
11. Depth of same?		7 inches	8 inches	5 to 6 inches	12 inches.
12. Cost of same, per acre?		$3	$3		$3.
13. Time of second plowing?		October, 1878; May, 1879			May 10.
14. Depth of same?		7 inches		6 inches	12 inches.
15. Cost of same?		$2		$1.25	$2.
16. Was subsoil plowing employed?	No	No		No	No.
17. Depth of same?					
18. Note other operations of preparation of the soil and cost of same.	Harrowed 3 times	Harrowed and rolled; $1.50.	Harrowing; $1		Harrowing; $3.
19. Planting, date?	Middle of May	May 12	May 8 and 9	May 10	May 15.
20. Method of—by hand or drill?	Drill	By hand	By hand	By hand	Both.
21. Cost of planting?		$8	$4	$2.62½	$3.
22. Distance between the rows?	1½ and 3½ feet	30 inches	3 feet	22 inches	
23. Distance between the roots?	8 inches.	8 inches	6 inches	4 to 8 inches	8 to 10 inches.
24. Was stable manure applied to the crops?	8 cords per acre	Yes; at planting	5 cords; $20	Yes; just before planting	Yes.
25. When, and in what quantity per acre?	Yes	7 cords; cost $21	Spread before plowing	About 3½ cords	12 cords per acre; $60.
26. Was artificial manure applied?	Yes; at time of planting.	Yes; Bradley's fertilizer	Yes; Stockbridge fertilizer.	Yes; (XL) phosphate	Yes; 400 pounds Stockbridge.
27. When; how; what; how much; cost?	300 lbs.; superphosphate.	1,500 pounds; cost $22	In drills; 500 lbs.; cost $10	350 pounds; cost $7.87½	Fertilizer; cost $10.
28. Time of first hoeing?	June	June 19	1st of June	About June 5	June 5 to 10.
29. Done by hand or horse cultivator?	Hand, mostly	Horse cultivator			Both.
30. If special implement used, describe it					Pettengill's horsehoe.
31. Cost of first hoeing?	$4	$10	$8	$1.50	$3.
32. Area hoed by each laborer per day?		⅛ of an acre		¼ of an acre	About 32 rods.
33. Wages of laborers, by day or month	$1 per day	$15 and board	$1 per day		$15 and board.
34. Time and cost of second hoeing?	June 23 and 24; $12	June 30; $8	Last of June; $4	June 20; $5.25	1st of July; $3.
35. Date and cost of third hoeing?	July; latter part; $6	August 4; $6	$3	July; $1	August; $3.
36. Date and cost of thinning?	June 23 and 24	June 19			
37. How was thinning done; by hand, hoe, or special implement for the purpose?	Hand hoe	Harrow hoe	By hand	By hand	Hand and hoe.
38. Time of harvesting?	October 20 and 30	October 13 to 18	October 14 and 15	October 20	Finished October 29.
39. Mode of pulling, by hand or with instrument?	Fork	By hand	By hand	By hand	Hand.

40. Surface pulled by each man per day?	½ acre		⅓ of an acre	¼ of an acre	About 30 rods.
41. Mode of removing leaves or tops; by hand or with knife?	Knife	Knife	Knife	Knife	Knife.
42. Quantity topped by each laborer per day?					About 35 pounds.
43. Total cost of harvesting per acre?	$10	$15	$7.50	$10.50	$16.
44. Per ton of roots?		75 cents	50 cents		$1.
45. Distance of crop from station, wharf, or factory?	½ mile	3 miles from station	1½ miles from station	3½ miles from station	2 miles.
46. Cost of delivery?	20 cents per ton	$15 per acre	$7.50 per acre	$1 per ton	50 cents per ton.
47. Price received per ton of beets?	$5	$5 for 2,240 pounds	$5	$5	$5.
48. Are beets preserved in trenches?					No.
49. How long?					
50. Cost of preparing trenches?					
51. Pulp, how obtained?	Railroad from factory				
52. Price of pulp at the factory?	50 cents				$1.
53. Cost delivered on farm?	$1.10		$2.		$2.80.
54. Estimated feeding value as compared with hay or corn fodder?					
55. Mode of preserving?	Pits				
56. Cost of same?	Nominal				
57. Mode of feeding?	With cut corn or hay				
58. To what animals fed?	Milch-cows, swine, sheep, &c.				
59. Quantity per day per head?					
60. What percentage of sugar in your beets?		Sugar company report about 12 per cent.			
61. What is their average size and yield per acre?		20 tons	15 tons	14 tons	16 tons per acre.
62. Place of beets in your rotation of crops?					After corn.
63. Cost of culture per acre:					
a. Of beets?	$29.25*	$116.70	$69.40	$59.40	$116.40.
b. Of corn?	$11.50	$68.60		$51.37½	$54.
c. Of potatoes?	$11.50	$57.50		$51.87½	$56.
64. Value of crops per acre:					
a. Of beets?		$100	$75	$70	$80.
b. Of corn?				$24.75	$65.
c. Of potatoes?				$50.40	$60.
65. Average yield per acre:					
a. Of beets; tons?	10 to 20 tons	20 tons	15 tons	14 tons	16 tons.
b. Of corn; bushels?		60 bushels		33 bushels	
c. Of potatoes; bushels?		175 bushels		168 bushels	

*Grower's estimate.

CONDITION OF SUGAR-BEET CULTURE IN MAINE—Continued.

Number of entry	66	67	68	69	70
1. Kind of seed sown?	Sugar beet			Sugar beet	White sugar beet.
2. Source of same?	Maine Beet Sugar Co	France and Germany	Maine Beet Sugar Co	Maine Beet Sugar Co	Germany.
3. Quantity sown per acre?	13 pounds	6 pounds	About 12 pounds	10 pounds	4 pounds.
3a. Cost of same?	$2.60	$1.20	$2.40	$2	$1.60.
4. Location of field, upland or lowland?	Lowland	Upland	Upland	Side hill	Upland.
5. Is your soil sand, limestone, clay, slate, or loam?	Loam	Clay loam	Fine slate loam	Loam	Sandy loam.
6. Is it well drained?	Yes	Underdrained	Yes	Yes	
7. Is the drainage natural or artificial?	Natural	Artificial	Natural	Natural	
8. Area planted in sugar beets?	1 acre	1½ acres	½ acre	½ acre	½ acre.
9. Crop on same land previous year?	Corn	Potatoes	Grass	Corn	Corn.
10. Time of first plowing?	October 20	Late in fall of 1878	August, 1878	About May 15, 1878	Fall.
11. Depth of same?	8 inches	About 9 inches	6 to 8 inches	12 inches	8 inches.
12. Cost of same, per acre?	$3	About $1.75 per acre	$3	$2.50	$1.
13. Time of second plowing?	May 6	May 1, 1879		May 1, 1879	Spring.
14. Depth of same?	10 inches			12 inches	7 inches.
15. Cost of same?	$2	$1.75		$2	$1.
16. Was subsoil plowing employed?	No	No	No	No	No.
17. Depth of same?					
18. Note other operations of preparation of the soil, and cost of same.	Harrowing; $1	Harrowing; $1.50	Cost of preparing, $1	Harrowing; 50 cents	Harrowing; 50 cents.
19. Planting, date?	May 12	May 12	March 15, 1879	About May 10, 1879	May 1.
20. Method of—by hand or drill?	By hand	By hand	Drill	Drill	By hand.
21. Cost of planting?	$6	About $4 per 1½ acres	About 25 cents		$2.
22. Distance between the rows?	24 inches	30 inches	30 inches	2½ feet	2 feet.
23. Distance between the roots?	From 6 to 8 inches	8 inches	6 inches	8 inches	8 inches.
24. Was stable manure applied to the crops?	Yes	No	Yes	Yes	Yes.
25. When, and in what quantity per acre?	10 cords first; 8 second		In spring; 20 cords per acre.	8 cords; $24	5 cords; $25.
26. Was artificial manure applied?	Yes; Stockbridge fertilizer.	Yes; 800 pounds; $20	Yes; 500 pounds; cost $10.95.	Yes; phosphate of lime.	Yes; Bradley's superphosphate.
27. When; how; what; how much; cost?	Cost $15	Stockbridge fertilizer	Bradley's phosphate; in drills.	In drills; 260 pounds; $5.80.	250 pounds; $5.
28. Time of first hoeing?	June 1	July 1	June 10	About June 10	June 10.
29. Done by hand or horse cultivator?	By hand	By hand	With horse	Horse	By hand.
30. If special implement used, describe it					
31. Cost of first hoeing?	$6	$14 per 1½ acres	$7	$7	$2.
32. Area hoed by each laborer per day?	⅙ of an acre	⅓ of an acre			¼ of an acre.
33. Wages of laborers, by day or month?	75 cents	75 cts. per day and board	$1 per day	75 cents per day	
34. Time and cost of second hoeing?	$4	Aug. 1; $1.50	July 15; $8	June 20; $5	June; $2.
35. Date and cost of third hoeing?	July 1; $4		Aug. 10; $3	August 1; $4	
36. Date and cost of thinning?	June 5; $8				July 15; $3.
37. How was thinning done; by hand, hoe, or special implement for the purpose?	By hand	By hand	By hand	Hand and hoe	By hand.

38. Time of harvesting?	Last of October	Middle of October	October 20		October 10.
39. Mode of pulling, by hand or with instrument?	By hand	By hand		Hand	By hand.
40. Surface pulled by each man per day?	$\frac{1}{10}$ of an acre	$\frac{1}{2}$ acre			$\frac{1}{2}$ acre.
41. Mode of removing leaves or tops; by hand or with knife?	By hand	Knife			Knife.
42. Quantity topped by each laborer per day?	2 tons	$\frac{1}{2}$ acre			3 tons per day.
43. Total cost of harvesting per acre?	$10	$6	$14	$8	$12.
44. Per ton of roots?	90 cents		$1.25		
45. Distance of crop from station, wharf, or factory?	3½ miles	6 miles	2 miles from station	¼ mile from station	2½ miles.
46. Cost of delivering?	$9 per acre	$1.50 per ton	75 cents per ton		$5 per acre.
47. Price received per ton of beets?	$5	$5	$5 for 2,240 pounds	$5	$5.
48. Are beets preserved in trenches?			No		
49. How long?					
50. Cost of preparing trenches?					
51. Pulp, how obtained?					
52. Price of pulp at the factory?		$1 per ton			
53. Cost delivered on farm?		$2.30			
54. Estimated feeding value as compared with hay or corn-fodder?					
55. Mode of preserving?					
56. Cost of same?					
57. Mode of feeding?					
58. To what animals fed?					
59. Quantity per day per head?					
60. What percentage of sugar in your beets?					
61. What is their average size and yield per acre?		3 pounds; 6 tons	12¾ tons per acre	14 tons per acre	Average 3 pounds; 10 tons per acre.
62. Place of beets in your rotation of crops?	The lowest	Second			
63. Cost of culture per acre:					
a. Of beets?	$76.60	$54.70	$119.15	$60.80*	$60.10.
b. Of corn?	$65.40				
c. Of potatoes?			$29.50		
64. Value of crops per acre:					
a. Of beets?	$60	$30	$63.75	$70	$50.
b. Of corn?	$14.75				
c. Of potatoes?					
65. Average yield per acre:					
a. Of beets; tons?	12 tons	28 tons last year	12¾ tons	14 tons	10 tons per acre.
b. Of corn; bushels?					
c. Of potatoes; bushels?			150 bushels		

* Cost of delivering not included.

CONDITION OF SUGAR BEET CULTURE IN MAINE—Continued.

Number of entry	71	72	73	74	75
1. Kind of seed sown?	Sugar beet seed	German beet seed	Sugar beet seed	Sugar beet	
2. Source of same?		Maine Beet Sugar Co	Maine Beet Sugar Co	Maine Beet Sugar Co	Germany.
3. Quantity sown per acre?	14 pounds to the acre	14 pounds	14 pounds	7 pounds	7 pounds.
3a. Cost of same?	$2.80	$2.80	$2.80	$1.40	$1.40.
4. Location of field, upland or lowland?	Upland	Upland	Lowland	Upland	Upland.
5. Is your soil sand, limestone, clay, slate, or loam?	Clay loam	Sandy loam	Clay loam	Sandy loam	Gravelly loam.
6. Is it well drained?	Yes	Yes	No	Yes	Yes.
7. Is the drainage natural or artificial?	Artificial	Natural	Natural	Natural	Both.
8. Area planted in sugar beets?	Quarter of an acre	½ acre	¼ acre	1 acre	½ acre.
9. Crop on same land previous year?	Potatoes	Corn	Cucumbers	Corn	Corn.
10. Time of first plowing?	May 1	October, 1877	May 17	Fall	May 1.
11. Depth of same?	10 inches	10 inches	8 inches	9 inches	6 inches.
12. Cost of same, per acre?	$2.50	$3.25	$2	$2	$3.50 per acre.
13. Time of second plowing?		October, 1878		May 1	
14. Depth of same?		10 inches		12 inches	6 to 8 inches.
15. Cost of same?		$2.50		$3	$3.50 per acre.
16. Was subsoil plowing employed?		No		No	No.
17. Depth of same?		Harrowing, &c.; $2.50			
18. Note other operations of preparation of the soil, and cost of same.	Well harrowed		50 cents		Harrowed; cost $2 per acre.
19. Planting, date?	May 15	May 13 and 14	May 17	May 7 to 15	May 24.
20. Method of—by hand or drill?	By hand	By hand	Drill	By hand	Hand.
21. Cost of planting?	$2	$8.50	$1	$1	$4 per acre.
22. Distance between the rows?	18 inches	22 inches	26 inches	28 inches	30 inches.
23. Distance between the roots?	8 inches	6 to 8 inches	8 inches	8 inches	6 to 8 inches.
24. Was stable manure applied to the crops?	Stable manure; $48	Yes	Barn-yard manure	Yes	Yes, after second plowing.
25. When, and in what quantity per acre?	12 cords to the acre	April, 1879; 24 c. per acre	In drills; 10 cords per acre. $40.	In drills; 6 cords per acre. $24.	10 cords per acre; $50.
26. Was artificial manure applied?	Stockbridge; 200 pounds	Yes; Bradley's phosphate.	No	No	Yes; at time of planting; 800 pounds
27. When; how; what; how much; cost?	On ¼ of an acre; in drills; $20 per acre.	In drills; cost $5			Superphosphate; per acre; $18.
28. Time of last hoeing;		Last of May	June 10	Commenced June 2	June 25.
29. Done by hand or horse cultivator?	Cultivator	Both	Both	By hand	Horse cultivator.
30. If special implement used, describe it				Common hoe	
31. Cost of first hoeing?	75 cents	$3	$1	$12	$6 per acre.
32. Area hoed by each laborer per day?			¼ acre	Small piece	⅙ of an acre.
33. Wages of laborers, by day or month?		$1 per day	70 cents	From 50 to 75 cts per day.	$1 per day.
34. Time and cost of second hoeing?	June 25; $1	June 16; $3	$1	Last of June; cost $12	July, $12.
35. Date and cost of third hoeing?	July 15; $1	July 1; $2	75 cents		July 27, $12.
36. Date and cost of thinning?	July 10; $2		June 27; $1.50	June 1; $4	July 3, $12.

37. How was thinning done; by hand, hoe, or special implement for the purpose?	By hand	By hand	By hand	By hand	By hand.
38. Time of harvesting?	October 15	October 22	October 2	Oetober 20	October 18.
39. Mode of pulling, by hand or with instruments?	By hand	By hand	By hand	By hand	Hand.
40. Surface pulled by each man per day?	½ acre		⅛ acre	¼ acre	1/12 of an acre.
41. Mode of removing leaves or tops; by hand or with knife?	Knife	Knife	Knife	Knife	Knife.
42. Quantity topped by each laborer per day?	¼ acre		2 tons	⅛ acre	
43. Total cost of harvesting per acre?	$6	$3 for pulling and topping.	$6 per acre	$6	$15.
44. Per ton of roots?				30 cents	
45. Distance of crop from station, wharf, or factory?	2 miles from station.	½ mile to wharf	4 miles from station	1¼ miles	5 miles.
46. Cost of delivering?	$4 per acre	$2.25 per acre	$2 per acre	$6 per acre	$1.25 per ton.
47. Price received per ton of beets?	$5	$6	$5	$5	$5.
48. Are beets preserved in trenches?					No.
49. How long?					
50. Cost of preparing trenches?					
51. Pulp, how obtained?					
52. Price of pulp at the factory?					
53. Cost delivered on farm?				$1.50	
54. Estimated feeding value as compared with hay or corn fodder?					
55. Mode of preserving?					
56. Cost of same?					
57. Mode of feeding?					
58. To what animals fed?					
59. Quantity per day per head?					
60. What percentage of sugar in your beets?					
61. What is their average size and yield per acre?	20 tons per acre	11 tons	16 tons per acre	About 20 tons per acre	16½ tons.
62. Place of beets in your rotation of crops?					
63. Cost of culture per acre:					
a. Of beets?	$90.05 per acre	$37.80*	$60.50	$70.40	$160.02.
b. Of corn				$19.65	
c. Of potatoes?				$34.50	
64. Value of crops per acre:					
a. Of beets?	$100	$66	$80	$100	$82.50.
b. Of corn?					
c. Of potatoes?					
65. Average yield per acre:					
a. Of beets; tons?				20 tons	$16½ tons.
b. Of corn; bushels?				120 bushels	
c. Of potatoes; bushels?				100 bushels	

* Not including stable manure.

CONDITION OF SUGAR-BEET CULTURE IN MAINE—Continued.

Number of entry	76	77	78	79	80
1. Kind of seed sown?	Sugar beet		French and German		Sugar beet.
2. Source of same?	Maine Beet Sugar Co		Maine Beet Sugar Co	Maine Beet Sugar Co	Scotland.
3. Quantity sown per acre?	7 pounds	14 pounds per acre	14 pounds	10 pounds	15 pounds.
3a. Cost of same?	$1.40	$2.80	$2.80	$2	$3.
4. Location of field, upland or lowland?	Upland	Lowland	7 different pieces; bottom and upland.	Upland	Lowland.
5. Is your soil sand, limestone, clay, slate, or loam?	Clay loam	Clay loam	Sandy, gravelly, and clay	Loam with clay subsoil	Sand and loam.
6. Is it well drained?	Yes	Yes	Partly	Yes	Yes.
7. Is the drainage natural or artificial?	Natural	Natural	1 artificial; 1 natural	Natural	Natural.
8. Area planted in sugar beets?	¼ of an acre	¼ of an acre	5 acres in all	½ acre	1 acre.
9. Crop on same land previous year?	Corn	Potatoes	Hops, corn, and potatoes	Corn	
10. Time of first plowing?	May 28	May	About May 20	May 20	
11. Depth of same?	8 inches	8 inches	Average 12 to 14 inches	10 inches	About 8 inches.
12. Cost of same, per acre?	$1.50	$5 per acre	$3.50 per acre	$1.50	$2.
13. Time of second plowing?		May	Same as first		
14. Depth of same?		8 inches			
15. Cost of same?		$4	$2		
16. Was subsoil plowing employed?	No	No	No	No	No.
17. Depth of same?		9 inches			
18. Note other operations of preparation of the soil, and cost of same.	Harrowed thoroughly; 75 cents.	Harrowing; $3 per acre.	Harrowing, &c.; $2 per acre.	Harrowed well; $1.50	Harrowed.
19. Planting, date?	May 30 (too late)	May 25	From 20th to 30th of May	May 26	18th of May.
20. Method of—by hand or drill?	By hand	By hand	Norton's hand-sower	Hand	By hand.
21. Cost of planting?	$6	$3 per acre	$3.50 per acre	$4	$1.50.
22. Distance between the rows?	1 foot 1st row; 2½ feet 2d row.	24 inches	2 feet	30 inches	28 inches.
23. Distance between the roots?	6 inches	8 inches	6 to 8 inches	8 to 10 inches	6 inches.
24. Was stable manure applied to the crops?	No	Yes; 9 cords per acre	On one piece	Yes; partly; $12	Yes.
25. When, and in what quantity per acre?			In drill; about 4 cords; $16.	4 cords fine old manure	15th of May; 13 cords.
26. Was artificial manure applied?	Yes; Bradley's; 600 lbs per acre; cost, $15	No	Stockbridge beet fertilizer.	Yes; Stockbridge fertilizer.	150 bushels of ashes.
27. When; how; what; how much; cost?			200 lbs.; $5; good result	$20 per acre	Cost $65.
28. Time of first hoeing?	June 25	June 15	About June 10		19th of June.
29. Done by hand or horse cultivator?	By hand	By hand	Both; 3 little cutters	Horse cultivator	Both.
30. If special implement used, describe it?			V shaped, made of sheet metal.		
31. Cost of first hoeing?	$6 per acre	$6 per acre	$5	$5	$4.
32. Area hoed by each laborer per day?	⅛ of an acre	¼ per day			
33. Wages of laborers, by day or month?	75 cents per acre	$14 per month	Average $1 per day		
34. Time and cost of second hoeing?	Last of July; cost $6 per acre.	$4 per acre	June 29; $6	$5	July 8; $4.
35. Date and cost of third hoeing?		August 10, $4 per acre	$11	$5	
36. Date and cost of thinning?		June 20; $5 per acre	Included in 3d hoeing	$5	June 22; $10

37. How was thinning done; by hand, hoe, or special implement for the purpose?		Hand	By hand	By hand	By hand and hoe.
38. Time of harvesting?	Last of October	October 12	2d week in October	Last of October	October 25.
39. Mode of pulling, by hand or with instrument?	By hand	Hand	By hand		By hand.
40. Surface pulled by each man per day?	$\frac{1}{8}$ of an acre	$\frac{1}{4}$ acre per day	About $\frac{1}{4}$ of an acre		$\frac{1}{6}$ of an acre.
41. Mode of removing leaves or tops; by hand or with knife?		Knife	Knife	Knife	Knife.
42. Quantity topped by each laborer per day?		2 tons per day	About 2 tons		$\frac{1}{6}$ of an acre.
43. Total cost of harvesting per acre?	$6	$10 per acre	$13	$14	$12.
44. Per ton of roots?					
45. Distance of crop from station, wharf, or factory?	4 miles from railroad station.	2 miles		$1\frac{3}{4}$ of a mile	1 mile from station.
46. Cost of delivering?	$2	$1 per ton	50 cents per ton	$8 per acre	$8 per acre.
47. Price received per ton of beets?	$5	$5 per ton	$5	$5	$6 per ton.
48. Are beets preserved in trenches?	No	Yes	None of mine; some are		
49. How long?			All winter		
50. Cost of preparing trenches?			From 50 to 75 cts. per ton		About 25 cents per ton.
51. Pulp, how obtained?					
52. Price of pulp at the factory?	$1				
53. Cost delivered on farm?					$2 per ton.
54. Estimated feeding value as compared with hay or corn fodder?					
55. Mode of preserving?					
56. Cost of same?					
57. Mode of feeding?					
58. To what animals fed?					
59. Quantity per day per head?					
60. What percentage of sugar in your beets?			Best 13 to 14 per cent		
61. What is their average size and yield per acre?	6 tons; size, $\frac{1}{2}$ to $2\frac{1}{2}$ in.	10 tons per acre	Yield 10 tons	12 tons	15 to 18 tons.
62. Place of beets in your rotation of crops?					
63. Cost of culture per acre:					
a. Of beets?	$44.65	$56.80*	$74.80	$78	$109.50.*
b. Of corn?	$62.25	$30	$52		
c. Of potatoes?	$42.75	$25	$71		$15.
64. Value of crops per acre:					
a. Of beets?	$30	$50	$50	$60	$90.
b. Of corn?	$45		$30		
c. Of potatoes?	$50		$16		
65. Average yield per acre:					
a. Of beets; tons?	6 tons	10 tons	10 tons per acre	12 tons	15 tons.
b. Of corn; bushels?	60 bushels		40 bushels		
c. Of potatoes; bushels?	125 bushels		40 bushels		200 bushels.

*Not including stable manure.

CONDITION OF SUGAR-BEET CULTURE IN MAINE—Continued.

Number of entry	S1	S2	S3	S4	S5
1. Kind of seed sown?	German seed		Sugar beet		Sugar beet.
2. Source of same?	Maine Beet Sugar Co	Maine Beet Sugar Co	Portland, Me	Maine Beet Sugar Co	Maine Beet Sugar Co.
3. Quantity sown per acre?	12 pounds	14 pounds per acre	10 pounds	6 pounds	8 pounds.
3a. Cost of same?	$2.40	$2.80	$2	$1.20	$1.60.
4. Location of field, upland or lowland?	Upland	Lowland	Level	Elevated	Upland.
5. Is your soil sand, limestone, clay, slate, or loam?	Slate	Clay loam	Sand and clay loam	Clay loam	Loam.
6. Is it well drained?	Yes	Yes	Yes	Yes	Yes.
7. Is the drainage natural or artificial?	Natural	Artificial	Natural	Natural	Natural.
8. Area planted in sugar beets?	½ acre	½ an acre	⅛ of an acre	¾ of an acre	½ acre.
9. Crop on same land previous year?	Corn	Cabbage	Corn	Barley	Potatoes.
10. Time of first plowing?	May	7th of May	May 10	Fall of 1867	November.
11. Depth of same?	10 inches	About 8 inches	10 inches	8 inches	6 inches.
12. Cost of same per acre?	$3	$1.50 per acre	$3	$3	$2.
13. Time of second plowing?					May 15.
14. Depth of same?				6 or 7 inches	7 inches.
15. Cost of same?				$3	$2 per acre.
16. Was subsoil plowing employed?	No		No	No	Yes.
17. Depth of same?					6 inches.
18. Note other operations of preparation of the soil, and cost of same.	$2	Harrowing; 50 cents	⅛ of a day harrowing	Harrowing, $3	Well harrowed; 50 cents.
19. Planting, date?	June 1	May 13	May 15	May 20	May 20.
20. Method of—by hand or drill?	Hand	Drill	Drill	Both	Hand.
21. Cost of planting?	$2	$1.50 per acre	$1	$8	$3.
22. Distance between the rows?	3 feet	About 18 inches	20 inches	24 inches	2 feet.
23. Distance between the roots?	8 to 10 inches	6 to 8 inches	8 inches		8 inches.
24. Was stable manure applied to the crops?	Yes	Yes; 4 cords to ½ acre	Yes	Yes; $30	Yes.
25. When, and in what quantity per acre?	10 cords to the acre; $40	Spread broadcast; $16	4 cords; $16	Spring; 10 cords per acre.	8 cords.
26. Was artificial manure applied?	Yes, in drill; 450 pounds	Yes, in drills; 100 pounds	Yes, 50 pounds; $1	Yes	Yes; cost $24.
27. When; how; what; how much; cost?	At time of planting; $10	Cumberland phosphate, per ½ acre, $2.	Bradley's phosphate	35 bushels of fish; beets ⅛ better where fish was.	800 pounds per acre; $20.
28. Time of first hoeing?	Middle of June	June 10	June 6	About 2 inches high	July 19.
29. Done by hand or horse cultivator?	By hand	Horse cultivator	Hand	Hand	Hand.
30. If special implement used, describe it			50 cents		
31. Cost of first hoeing?	$2	$2		$6	$4.
32. Area hoed by each laborer per day?	$1	½ acre		⅛ of an acre	½ acre.
33. Wages of laborers, by day or month?	4 days; $4	$14 per month			
34. Time and cost of second hoeing?		June 26; $1.50		$6	July 5; $4.
35. Date and cost of third hoeing?					August 14; $4.
36. Date and cost of thinning?	Thinned at second hoeing	About July 8; 50 cents	50 cents	Last of June; $6	June 26; $2.50.
37. How was thinning done; by hand, hoe, or special implement for the purpose?	By hand	By hand	By hand	By hand	Hand.
38. Time of harvesting?	Last of October	October 11	October 27, 1879	Last of October	October 24.
39. Mode of pulling, by hand or with instrument?	By hand	With fork	By hand	Hand	

40. Surface pulled by each man per day?	½ of an acre		About ½ acre		
41. Mode of removing leaves or tops; by hand or with knife?	Knife	Knife	By hand	Knife	Knife.
42. Quantity topped by each laborer per day?	3 tons		About 4 tons		¼ acre.
43. Total cost of harvesting per acre?	$6	$6 per ½ acre	$12	$18	$24 per acre.
44. Per ton of roots?					
45. Distance of crop from station, wharf, or factory?	9 miles from factory	3 miles	4½ miles	2 miles	
46. Cost of delivering?	$2 per ton	75 cents per ton	$1.50	$6 per acre	
47. Price received per ton of beets?	$6	$6	$5 per ton	$5	$5.
48. Are beets preserved in trenches?	Yes				
49. How long?	Until spring				
50. Cost of preparing trenches?					
51. Pulp, how obtained?					
52. Price of pulp at the factory?					$2 per ton at station.
53. Cost delivered on farm?	$2 per ton				$1.
54. Estimated feeding value as compared with hay or corn-fodder?					
55. Mode of preserving?					
56. Cost of same?					
57. Mode of feeding?					
58. To what animals fed?					
59. Quantity per day per head?					
60. What percentage of sugar in your beets?					
61. What is their average size and yield per acre?	18 tons per acre	16 tons	25 to 30 tons	3 inches; 16 tons per acre.	2 pounds.
62. Place of beets in your rotation of crops?	Lowest	Third		The least	One-tenth.
63. Cost of culture per acre:					
a. Of beets?	$105.40	$70.30		$90.20	$91.60.
b. Of corn?					
c. Of potatoes?					
64. Value of crops per acre:					
a. Of beets?	$108	$96	$150	$80	$95.
b. Of corn?					
c. Of potatoes?					
65. Average yield per acre:					
a. Of beets; tons	18 tons	16 tons	30 tons	16 tons	19 tons.
b. Of corn; bushels					30 bushels.
c. Of potatoes; bushels					150 bushels.

CONDITION OF SUGAR-BEET CULTURE IN MAINE—Continued.

Number of entry	86	87	88	89	90
1. Kind of seed sown?	Sugar beet	White sugar beet	Sugar beet	Sugar beet	
2. Source of same?	Imported from France	Imported	Germany	Maine Beet Sugar Co.	Maine Beet Sugar Co.
3. Quantity sown per acre	12 pounds	10 pounds	1⅞ pounds	12 pounds	28 pounds.
3a. Cost of same?	$2.40	$2	$0.35	$2.40	$5.60.
4. Location of field, upland or lowland?	Upland	Lowland	Lowland	Upland	Lowland.
5. Is your soil sand, limestone, clay, slate, or loam?	Sand	Lim stone	Sandy loam	Loam	Black loam.
6. Is it well drained?	Yes	Yes	Only surface drain	Yes	Partly drained.
7. Is the drainage natural or artificial?	Natural	Artificial	Natural	Natural	Artificial.
8. Area planted in sugar beets?	¼ of an acre	1 acre	¼ of an acre	½ of an acre	½ acre.
9. Crop on same land previous year?	Beets	Potatoes	Cabbage	Corn	Potatoes.
10. Time of first plowing?	May 5	May 20	May 28	October, 1878	Late in fall.
11. Depth of same	9 inches	8 inches	8 inches	8 inches	6 inches.
12. Cost of same per acre?	$2 per acre	$2	62 cents per ¼ acre	$2	$1 per ½ acre.
13. Time of second plowing?				May 8, 1879	May 14.
14. Depth of same?				9 inches	10 inches.
15. Cost of same?				$1.50	$1.25 per ½ acre.
16. Was subsoil plowing employed?	No	No	No	Yes	No.
17. Depth of same?				12 inches	Ought to be 15 in. deep.
18. Note other operations of preparation of the soil, and cost of same?		$1; harrowing	Harrowing, 25 cents per ¼ acre.		
19. Planting, date?	May 10	May 25	June 1	May 19	25th of May.
20. Method of—by hand or drill?	Drill	Machine	By hand	By hand	By hand.
21. Cost of planting?	$1.50 per acre	$5	$1.50	$4 per acre	$2 per ½ acre.
22. Distance between the rows?	20 inches	3 feet	2 feet	3 feet	24 inches.
23. Distance between the roots?	8 inches	8 inches	10 inches	6 to 8 inches	5 inches.
24. Was stable manure applied to the crops?	Yes	Yes; cost $24	No	Yes	Yes; 24th of May.
25. When, and in what quantity per acre?	4 cords; $16	May 25; 8 cords	Yes; Stockbridge fertilizer in drills; 375 pounds; $7.50; at time of planting.	16 cords	10 loads to the acre; $10.
26. Was artificial manure applied?	Yes; May 10, 400 pounds.	No		Yes; 560 lbs. Cumberland phosphate per acre; $13.80.	Yes; Stockbridge fertilizer; 400 pounds per ½ acre; $10.
27. When; how; what; how much; cost?	Bradley's phosphate; $10				
28. Time of first hoeing?	June 1	June 10	July 3	June 30	15th of June.
29. Done by hand or horse cultivator?	By hand	Both	Horse cultivator	By hand	Horse cultivator.
30. If special implement used, describe it?					
31. Cost of first hoeing?	$2.50	$6	50 cents	$2.50 per acre	$2.
32. Area hoed by each laborer per day?	½ acre	⅙ of an acre		About ½ of an acre	
33. Wages of laborers, by day or month?	$1.25 per day	$1 per day	$1.25 per day	$1 per day	
34. Time and cost of second hoeing?	$2 per acre	June 20; about $4	July 28; $1.50 per ¼ acre.	2 days; $2	1st of July; $2.
35. Date and cost of third hoeing?		July 12; about $4		July 12; $1.50 per acre	15th of July; $2.
36. Date and cost of thinning?	Last of June; $2		July 1; $1.25 per ¼ acre	June 23; $15	July 5; $3 per ½ acre.
37. How was thinning done; by hand, hoe, or special implement for the purpose?	Hand	By hand	By hand	By hand	By hand.
38. Time of harvesting?	Oct. 15	October 15	October 22	October 15 to 22	October 1.
39. Mode of pulling, by hand or with instrument?	Hand	By hand	By hand	By hand	By hand.

40. Surface pulled by each man per day?	⅛ of an acre	1 acre		¼ of an acre	
41. Mode of removing leaves or tops; by hand or with knife?	By hand	Knife	Knife	With knife	Knife.
42. Quantity topped by each laborer per day?	2½ tons	3 tons		¼ of an acre	3 tons.
43. Total cost of harvesting per acre?	$8	$5		$8	$6.
44. Per ton of roots?		50 cents			
45. Distance of crop from station, wharf, or factory?	1 mile	2 miles from railroad station.	2½ miles	6 miles	2½ miles.
46. Cost of delivering?	50 cents per ton	75 cents per ton		50 cents per ton	$4.
47. Price received per ton of beets?	$5	$5	$5	$5	$5.
48. Are beets preserved in trenches?	No	No			No.
49. How long?					
50. Cost of preparing trenches?					
51. Pulp, how obtained?		By railroad			
52. Price of pulp at the factory?		$1 per ton			
53. Cost delivered on farm?		$2			$1.80.
54. Estimated feeding value, as compared with hay or corn fodder?					
55. Mode of preserving?					
56. Cost of same?					
57. Mode of feeding?					
58. To what animals fed?					
59. Quantity per day per head?					
60. What percentage of sugar in your beets?					
61. What is their average size and yield per acre?	From 2 to 3 pounds; 17 tons per acre.	2 pounds; 10 tons	3 to 4 inches; 16 tons per acre.	3 pounds; 14 tons per acre.	1 pound; 14 tons per acre
62. Place of beets in your rotation of crops?	Fourth				
63. Cost of culture per acre:					
a. Of beets?	$54.90	$60.50		$59.70	$64.10.
b. Of corn?					
c. Of potatoes?					
64. Value of crops per acre:					
a. Of beets?	$85	$50	$80	$70	$70.
b. Of corn?	$66				
c. Of potatoes?	$75				
65. Average yield per acre:					
a. Of beets, tons?	17 tons per acre	10 tons	16 tons	14 tons	14 tons.
b. Of corn, bushels?					
c. Of potatoes, bushels?		150 bushels			

CONDITION OF SUGAR-BEET CULTURE IN MAINE—Continued.

Number of entry	91	92	93	94	95
1. Kind of seed sown?	White French sugar beet		White German		White sugar beet.
2. Source of same?	Maine Beet Sugar Co		Maine Beet Sugar Co	Maine Sugar Beet Co	
3. Quantity sown per acre?	14 pounds	14 pounds	About 10 pounds	5 pounds	6 pounds.
3a. Cost of same?	$2.80	$2.80	$2	$1	$1.20.
4. Location of field, upland or lowland?	Upland	Lowland		Lowland	Upland.
5. Is your soil sand, limestone, clay, slate, or loam?	Loam	Loam	Clay and sandy loam	Loam	Rocky loam.
6. Is it well drained?	Yes	Yes	Yes	Yes	Yes.
7. Is the drainage natural or artificial?	Natural	Natural	Both	Artificial	Natural.
8. Area planted in sugar beets?	½ acre	1 acre	1½ acres	1 acre	½ acre.
9. Crop on same land previous year?	Corn		Beets and sweet corn	Potatoes	Corn.
10. Time of first plowing?	May 20		Fall of 1878	May 14	2 years.
11. Depth of same?	From 6 to 8 inches	About 10 inches	About 8 inches	Between 8 and 10 inches.	10 inches.
12. Cost of same per acre?	$4	$2	$3	$2	$3.
13. Time of second plowing?			About May 1	Plowed but once	May.
14. Depth of same?			6 inches		10 inches.
15. Cost of same?			$2.50		$3.
16. Was subsoil plowing employed?	No	No	No		No.
17. Depth of same?					10 inches.
18. Note other operations of preparation of the soil, and cost of same.	Cultivating and harrowing; $3.	Harrowed twice; $2		Well harrowed; $1	
19. Planting, date?	May 25	May 20	1st to middle of May	May 17 and 24	June 1.
20. Method of—by hand or drill?	By hand	By hand	Drill	Drill	Drill.
21. Cost of planting?	$6	$4	75 cents	$1	$3.
22. Distance between the rows?	3 feet	2 feet	2 feet	2½ feet	18 inches.
23. Distance between the roots?	6 inches	8 inches	6 to 8 inches	8 inches	6 inches.
24. Was stable manure applied to the crops?	Yes; at time of planting.	No	Yes	Yes; 10 cords per acre	Barn-yard manure; $12.
25. When, and in what quantity per acre?	8 cords per acre; $32			At time of planting; $40.	In June; 20 loads per acre.
26. Was artificial manure applied?	No	Yes; 4 bags Stockbridge	Stockbridge fertilizer	No	No.
27. When; how; what; how much; cost?		$20	$20 per acre		
28. Time of first hoeing?	June 15	July 5		June 17	June 15.
29. Done by hand or horse cultivator?	By hand	Hand		Both	Hand.
30. If special implement used, describe it					
31. Cost of first hoeing?	$6	$5		$3	$3.
32. Area hoed by each laborer per day?				⅓ of an acre	⅛ of an acre.
33. Wages of laborers, by day or month?	75 cents	By day; $1		$1 per day	
34. Time and cost of second hoeing?	$3.75	$7		July 23; $3	Last of June; $3.
35. Date and cost of third hoeing?					1st of August; $3.
36. Date and cost of thinning?	June 25; $3			July 8; $8.50	June 25; $5.
37. How was thinning done; by hand, hoe, or special implement for the purpose?	By hand	By hand		By hand	By hand.
38. Time of harvesting?	October 18	October 15	October 26	October 15	October.
39. Mode of pulling, by hand or with instrument?	By hand	By hand		By hand	By hand.
40. Surface pulled by each man per day?	¼ of an acre		¼ of an acre	⅓ of an acre	¼ of an acre.

41. Mode of removing leaves or tops; by hand or with knife?	By hand	Knife	Knife	Knife	Knife.
42. Quantity topped by each laborer per day?	2 tons		2 tons	About 2 tons	50 bushels.
43. Total cost of harvesting per acre?	$15 per acre	$4		$8	$18.
44. Per ton of roots?				60 cents	$1.
45. Distance of crop from station, wharf, or factory?	2 miles from station	¼ mile from depot	2 miles	1 mile	3½ miles from station.
46. Cost of delivering?	$5 per acre	25 cents per ton	50 cents per ton	$6 per acre	$1.50 per ton.
47. Price received per ton of beets?	$5	$5	$5	$5	$5.
48. Are beets preserved in trenches?				No	
49. How long?					
50. Cost of preparing trenches?					
51. Pulp, how obtained?					
52. Price of pulp at the factory?					
53. Cost delivered on farm?					
54. Estimated feeding value as compared with hay or corn fodder?					
55. Made of preserving?					
56. Cost of same?					
57. Mode of feeding?					
58. To what animals fed?					
59. Quantity per day per head?					
60. What percentage of sugar in your beets?					
61. What is their average size and yield per acre?	16 tons per acre	4 tons	10 tons	5 inches; yield, 14 tons	3 to 4 pounds; 18 tons.
62. Place of beets in your rotation of crops?	Second				
63. Cost of culture per acre:					
a. Of beets?	$80.55	$47.80	$33.25	$73.50	$79.20.
b. Of corn?					
c. Of potatoes?					
64. Value of crops per acre:					
a. Of beets?	$80	$20	$50	$70	$90.
b. Of corn?					
c. Of potatoes?					
65. Average yield per acre:					
a. Of beets; tons?	16 tons	4 tons.	10 tons.	14 tons	18 tons.
b. Of corn; bushels?					
c. Of potatoes; bushels?					

CONDITION OF SUGAR-BEET CULTURE IN MAINE—Continued.

Number of entry	96	97	98	99	100
1. Kind of seed sown?		German	Sugar beet	Sugar beet	Sugar beet.
2. Source of same?	Maine Beet Sugar Co.	Maine Beet Sugar Co.		Germany	Germany,
3. Quantity sown per acre?	7 pounds	10 pounds		8 pounds	6 pounds.
3a. Cost of same?	$1.40	$2		$1.60	$1.20.
4. Location of field, upland or lowland?	Both	Lowland	Upland	Upland	Upland.
5. Is your soil sand, limestone, clay, slate, or loam?	Lime clay	Clay loam	Loam	Dry, gravelly	Gravelly loam.
6. Is it well drained?	No	Yes	Yes	Yes	Yes.
7. Is the drainage natural or artificial?	Natural	Natural	Natural	Natural	Natural.
8. Area planted in sugar beets?	¼ acre	½ acre	1 acre	½ acre	1 acre.
9. Crop on same land previous year?	Corn and potatoes	Beets	Potatoes	Beans	
10 Time of first plowing?	May 20	Spring	May	May	Autumn, 1878.
11. Depth of same?	8 inches	10 inches	10 inches	5 inches	6 inches.
12. Cost of same per acre	$3 per acre	$3	$3	$1.50	$2.
13. Time of second plowing?					May 25.
14. Depth of same?					8 inches.
15. Cost of same?	$3				$2.
16. Was subsoil plowing employed?	No			No	No.
17. Depth of same?					
18. Note other operations of preparation of the soil, and cost of same.			Harrowing; 50 cents	Harrowed well	Harrowed 3 times; $1.50.
19. Planting, date?	June 25	May 20	May 20	May 1	May 26.
20. Method of—by hand or drill?	By hand	By hand	Hand	Hand	Hand.
21. Cost of planting?	$2 per acre		$3	$2 per acre	$3.50.
22. Distance between the rows?	12 to 30 inches	30 inches	20 inches	3 feet	2 feet.
23. Distance between the roots?	8 to 10 inches	6 inches	1 foot	8 inches	6 inches.
24. Was stable manure applied to the crops?	Yes; 6 cords, $18		Yes	Yes; new	Yes; 6 cords; $18.
25. When, and in what quantity per acre?	Before plowing		May; 10 cords per acre	4 cords, $20	Plowed in at last plowing.
26. Was artificial manure applied?	No	Yes; Bradley's	No		Yes, at time of planting.
27. When; how; what; how much; cost?		200 pounds per acre; $5			Ashes; 350 bushels; $52.50.
28. Time of first hoeing?	June 10		June 20		Middle of June.
29. Done by hand or horse cultivator?	Hand	By hand	Hand	Both	Hand.
30. If special implement used, describe it					
31. Cost of first hoeing?	$8		$4	$1	$4.
32. Area hoed by each laborer per day?			¼ of an acre		
33. Wages of laborers, by day or month?	75 cents per day		$1 per day		
34. Time and cost of second hoeing?	June 25		August 1; $6		Last of June; $8.
35. Date and cost of third hoeing?	July 18; $8		September 5; $3		August 1; $5.
36. Date and cost of thinning?					July 1; $4.
37. How was thinning done; by hand, hoe, or special implement for the purpose?	By hand	By hand	Hand and hoe	Hand	Hand.
38. Time of harvesting?	October	October 15	October	October	October 27.
39. Mode of pulling, by hand or with instrument?	By hand	By hand	By hand	Hand	Hand.
40. Surface pulled by each man per day?			¼ acre per day		¼ of an acre.

41. Mode of removing leaves or tops; by hand or with knife?	Knife	Knife	Knife	Knife	Knife.
42. Quantity topped by each laborer per day?			6 tons		3 tons.
43. Total cost of harvesting per acre?	$8		$4	$12	$8.
44. Per ton of roots?			17 cents per ton		66 cents per ton.
45. Distance of crop from station, wharf, or factory?	¼ mile	2 miles	3 miles to station	½ mile to station	¾ of a mile.
46. Cost of delivering?		$1.50	$1 per ton	$2 per acre	40 cents per ton.
47. Price received per ton of beets?	$5	$5	$5	$5	$5.
48. Are beets preserved in trenches?	No			No	No.
49. How long?					
50. Cost of preparing trenches?					
51. Pulp, how obtained?					
52. Price of pulp at the factory?					
53. Cost delivered on farm?					
54. Estimated feeding value as compared with hay or corn fodder?					
55. Mode of preserving?					
56. Cost of same?					
57. Mode of feeding?					
58. To what animals fed?					
59. Quantity per day per head?					
60. What percentage of sugar in your beets?					
61. What is their average size and yield per acre?	Medium size; 12 tons	12 tons	Size 6 lbs.; yield 10 tons	9 tons per acre	12 tons per acre.
62. Place of beets in your rotation of crops?	Best				
63. Cost of culture per acre:					
a. Of beets?	$51.40			$50.10	$110.50.
b. Of corn?					
c. Of potatoes?					
64. Value of crops per acre:					
a. Of beets?	$60	$60	$50	$45	$60.
b. Of corn?					
c. Of potatoes?					
65. Average yield per acre:					
a. Of beets; tons?	12 tons	12 tons	10 tons	9 tons	12 tons.
b. Of corn; bushels?					
c. Of potatoes; bushels?					

CONDITION OF SUGAR-BEET CULTURE IN MAINE—Continued.

Number of entry	101	102	103	104	105
1. Kind of seed sown?		White sugar beet	Sugar Beet Company	White French beet	
2. Source of same?	Portland	Portland	Germany	Maine Beet Sugar Co	Maine Beet Sugar Co.
3. Quantity sown per acre?	About 10 pounds	14 pounds per acre	About 10 pounds	10 pounds	7 pounds.
3*a*. Cost of same?	$2	$2.80	$2	$2	$1.40
4. Location of field, upland or lowland?	Lowland	Upland	Lowland	Upland	Upland.
5. Is your soil sand, limestone, clay, slate, or loam?	Loam	Clay	Red loam	Sandy and clay loam	Partly clay.
6. Is it well drained?	Yes	Yes	Yes	Yes	Yes.
7. Is the drainage natural or artificial?	Natural	Natural	Natural	Natural	Natural.
8. Area planted in sugar beets?	¼ acre	12 square rods	½ acre	1 acre	1 acre.
9. Crop on same land previous year?		Family garden	Corn	Potatoes and carrots	Corn.
10. Time of first plowing?	May 1	May 4	Fall	May 8	Fall, 1878.
11. Depth of same?	8 inches	7 inches	About 6 inches	8 to 10 inches	8 inches.
12. Cost of same per acre?	$2 per acre	No estimate made	$3	$3	$1.50.
13. Time of second plowing?		May 14			Spring, 1879.
14. Depth of same?		7 inches	10 to 12 inches		8 miles.
15. Cost of same?			$3.50		$1.50.
16. Was subsoil plowing employed?			No	No	No.
17. Depth of same?					
18. Note other operations of preparation of the soil, and cost of same.	Harrowing; 50 cents	Harrowed once	Harrowing; $1.50	Harrowing; $7.50	Harrowing; $1.50.
19. Planting, date?	May 15	May 21	May 15	May 20 to 23	May 1.
20. Method of—by hand or drill?	Drill	By hand	By hand		Hand and drill.
21. Cost of planting?	About $2 per acre	Very small	$4	$6	75 cents.
22. Distance between the rows?	15 inches	30 inches	18 inches	2½ feet	2 feet.
23. Distance between the roots?	4 to 8 inches	8 inches	Yes	5 to 8 inches	6 inches.
24. Was stable manure applied to the crops?	Yes; May 1	Yes; May 14	In spring; 8 cords, $32	Yes; 15 cords in drills	No.
25. When, and in what quantity per acre?	7 cords per acre; $35	20 cords per acre; $60	Yes; 1,000 pounds	At planting; $45	
26. Was artificial manure applied?	No	Yes; 1 bag Stockbridge	Cost, $20	No	No.
27. When; how; what; how much; cost?		$5 per acre			
28. Time of first hoeing?	About June 1	June 14	June 1	June 9 and 10	Last of May.
29. Done by hand or horse cultivator?	By hand	Both	By hand	Both	Both.
30. If special implement used, describe it?					
31. Cost of first hoeing?	$3	Nominal	$5	$4	$4.25.
32. Area hoed by each laborer per day?	⅓ acre	¼ acre	⅓ acre	¼ acre	
33. Wages of laborers, by day or month?	$1.50 per day		$1 per day		
34. Time and cost of second hoeing?	Last of June; $4	June 24	Last of June; $5 per acre	June 23 and 24; $3	June 17; $3.
35. Date and cost of third hoeing?		July 2		July 4 and 5; $3	July 5; $2.
36. Date and cost of thinning?		Thinned at first hoeing	July 1; $8 per acre		
37. How was thinning done; by hand, hoe, or special implement for the purpose?	Hand and hoe	By hand	By hand	Hand and hoe	Both.
38. Time of harvesting?	October	October 20	Middle of October	October 14 to 25	October 18.
39. Mode of pulling, by hand or with instrument?	By hand	Hand and crow-bar	By hand	By hand	
40. Surface pulled by each man per day?			¼ acre	⅛ acre	

41. Mode of removing leaves or tops; by hand or with knife?	Both	Knife	Knife	Knife	Knife.
42. Quantity topped by each laborer per day?		4 tons	About 5 tons		1½ tons.
43. Total cost of harvesting per acre?	About $5	$6 per acre	$8	$8	$10.80.
44. Per ton of roots?					$1.20.
45. Distance of crop from station, wharf, or factory?	¼ mile from station	1½ miles from station	4½ miles	5 miles from station	6 miles to depot.
46. Cost of delivery?		$1 per ton	$1.50 per ton	$1.50 per ton	75 cents per ton.
47. Price received per ton of beets?	$5	$5	$5	$5	$5.
48. Are beets preserved in trenches?					
49. How long?					
50. Cost of preparing trenches?					
51. Pulp, how obtained?					
52. Price of pulp at the factory?					
53. Cost delivered on farm?					
54. Estimated feeding value as compared with hay or corn-fodder?					
55. Mode of preserving?					
56. Cost of same?					
57. Mode of feeding?					
58. To what animals fed?					
59. Quantity per day per head?					
60. What percentage of sugar in your beets?					
61. What is their average size and yield per acre?	12 tons	39 tons	20 tons per acre	23¾ tons	20 tons.
62. Place of beets in your rotation of crops?					
63. Cost of culture per acre:					
a. Of beets?	$53.50		$112	$114.12	$41.70.
b. Of corn?					
c. Of potatoes?					
64. Value of crops per acre:					
a. Of beets?	$60	$195	$100	$118.75	$100.
b. Of corn?					
c. Of potatoes?					
65. Average yield per acre:					
a. Of beets; tons?	12 tons	39 tons	20 tons	23¾ tons	20 tons.
b. Of corn; bushels?					
c. Of potatoes; bushels?					

CONDITION OF SUGAR-BEET CULTURE IN MAINE—Continued.

Number of entry	106	107	108	109	110
1. Kind of seed sown?		Imported seed	White French beet		Sugar beet.
2. Source of same?	Germany	Maine Beet Sugar Co	Maine Beet Sugar Co	Maine Beet Sugar Co	
3. Quantity sown per acre?	7 pounds	12 pounds	14 pounds	8 pounds	14 pounds per acre.
3a. Cost of same?	$1.40	$2.40	$2.80	$1.60	$2.80.
4. Location of field, upland or lowland?	Upland	Upland	Upland	Highland	Lowland.
5. Is your soil sand, limestone, clay, slate, or loam?	Loam	Sandy loam	Loam	Yes	Loam.
6. Is it well drained?	Yes	Yes	Yes	Natural	Yes.
7. Is the drainage natural or artificial?	Natural	Underdrained	Natural		Natural.
8. Area planted in sugar beets?	½ acre	1 acre	½ acre	100 square rods	½ acre.
9. Crop on same land previous year?	Corn and beans	Corn and potatoes	Corn	Sweet corn	Potatoes.
10. Time of first plowing?	October	Just before planting	May 5	May	November 14.
11. Depth of same?	8 inches	8 inches	11 inches	16 inches	10 inches.
12. Cost of same per acre?	$5.50	$3	$4	$2	$4.
13. Time of second plowing?	May		May 8		May 13.
14. Depth of same?	10 inches		10 inches		10 inches.
15. Cost of same?	$4.50		$4		$4 per acre.
16. Was subsoil plowing employed?	No	No	No	No	No.
17. Depth of same?					
18. Note other operations of preparation of the soil, and cost of same.		Harrowed; $1.50		Harrowing; $1	Harrowing; $1.50.
19. Planting, date?	May 15	Early in May	May 12	Middle of May	May 17.
20. Method of—by hand or drill?	Drill	Both	Drill	By hand	By hand.
21. Cost of planting?	$2	$3	$8	$5	$5.50.
22. Distance between the rows?	2 feet	18 inches	30 inches	26 inches	30 inches.
23. Distance between the roots?	6 to 8 inches	6 to 8 inches	8 inches	10 inches	8 inches.
24. Was stable manure applied to the crops?	Yes	Barn-yard manure	Yes; 8 cords, $40	Yes; 8 cords	Yes.
25. When, and in what quantity per acre?	12 cords; $72	4 to 5 cords	Second plowing	In May; $40	May 14; 6 cords per acre.
26. Was artificial manure applied?	No	Yes; Stockbridge and Bradley's.	No	No	Yes; Stockbridge, 800 pounds.
27. When; how; what; how much; cost?		$10			$20.
28. Time of first hoeing?	June 24		June 10	June 1	June 24.
29. Done by hand or horse cultivator?	Hand	Both	Hand	Both	By hand.
30. If special implement used, describe it					
31. Cost of first hoeing?	$22.50		$4	$10	$6 per ⅓ acre.
32. Area hoed by each laborer per day?			⅕ acre		⅛ acre.
33. Wages of laborers, by day or month?			$1 per day	$1 per day	$1 per day.
34. Time and cost of second hoeing?	July 1; $18.75		June 25; $3	Last of June; $5	July 31; $6 per ½ acre.
35. Date and cost of third hoeing?	August 1; $10		July 9; $3	Last of July; $3	
36. Date and cost of thinning?			$3		
37. How was thinning done; by hand, hoe, or special implement for the purpose?	Hand	Both	Both	Hand and hoe	By hand.
38. Time of harvesting?	October 20	Middle of October	October 23	Middle of October	October 15.
39. Mode of pulling, by hand or with instrument?	Hand	Fork	Hand	Hand	By hand.

40. Surface pulled by each man per day?	⅛ acre	¼ acre	½ acre	10 rods	¼ acre.
41. Mode of removing leaves or tops; by hand or with knife?	Knife	Knife	Knife	Knife	Knife.
42. Quantity topped by each laborer per day?	2 tons		1½ tons	¾ acre	2 tons.
43. Total cost of harvesting per acre?	$17		$10	$12	$10.
44. Per ton of roots?					
45. Distance of crop from station, wharf, or factory?	3 miles from station	2 miles	10 miles to factory	½ mile	4 miles from station.
46. Cost of delivering?	$1 per ton	$1 per ton	$1 per ton		$1 per ton.
47. Price received per ton of beets?	$5	$5	$6	$5	$5.
48. Are beets preserved in trenches?					Yes.
49. How long?					6 or 8 months.
50. Cost of preparing trenches?					
51. Pulp, how obtained?					
52. Price of pulp at the factory?					
53. Cost delivered on farm?					
54. Estimated feeding value as compared with hay or corn fodder?					
55. Mode of preserving?					
56. Cost of same?					
57. Mode of feeding?					
58. To what animals fed?					
59. Quantity per day per head?					
60. What percentage of sugar in your beets?					
61. What is their average size and yield per acre?	17 tons	Medium size; 10 tons per acre.	3 pounds; 12 tons		12 tons; size 2 pounds.
62. Place of beets in your rotation of crops?			First		
63. Cost of culture per acre:					
a. Of beets?	$170.65		$73.80	$79.60	$83.80.*
b. Of corn?					
c. Of potatoes?					
64. Value of crops per acre:					
a. Of beets?	$85	$50	$72	$65	$60.
b. Of corn?					
c. Of potatoes?					
65. Average yield per acre:					
a. Of beets, tons?	17 tons	10 tons	12 tons	13 tons	12 tons.
b. Of corn, bushels?					
c. Of potatoes, bushels?					

*Not including stable manure.

CONDITION OF SUGAR-BEET CULTURE IN MAINE—Continued.

Number of entry	111	112	113	114	115
1. Kind of seed sown?					Beet seed.
2. Source of same?	Maine Beet Sugar Co	Maine Beet Sugar Co	Maine Beet Sugar Co	Maine Beet Sugar Co	Maine Beet Sugar Co.
3. Quantity sown per acre?	14 pounds	12 pounds per acre	6 pounds	7 pounds	12 pounds.
3a. Cost of same?	$2.80	$2.40	$1.20	$1.40	$2.40.
4. Location of field, upland or lowland?	Lowland		Upland	Upland	Lowland.
5. Is your soil sand, limestone, clay, slate, or loam?	Clay loam	Sandy loam	Clay loam	Black loam	Clay loam.
6. Is it well drained?	Not well	Yes	Yes	Partly	No.
7. Is the drainage natural or artificial?	Artificial	Natural	Natural	Both	
8. Area planted in sugar beets?	1 acre	½ acre	½ acre	¾ acre	½ acre.
9. Crop on same land previous year?	Corn	Potatoes	Corn and beans	Corn	Corn.
10. Time of first plowing?	Fall of 1877	May	October 20, 1878	Fall, 1877	September, 1878.
11. Depth of same?	About 10 inches	9 inches	7 inches	9 or 10 inches	8 inches.
12. Cost of same per acre?	$5	$4 per acre	$2	$3	$5.
13. Time of second plowing?	Fall of 1878		April 15, 1879	Fall, 1878; again 1879	May, 1879.
14. Depth of same?	About 10 inches		9 inches	9 or 10 inches	6 inches.
15. Cost of same?	$4		$2 per acre	$2.40	$2.50 per acre.
16. Was subsoil plowing employed?	No	No	No	No	No.
17. Depth of same?					
18. Note other operations of preparation of the soil, and cost of same.			Harrowing; $1 per ½ acre	Harrowing; $1.60 per acre	Harrowed, &c.; $2 per acre.
19. Planting, date?	May 10 to 25	May 8 or 10	May 13	May 15	May 20.
20. Method of—by hand or drill?		By hand	In drill	Drill	By hand.
21. Cost of planting?	$5 or $6	$2 per ½ acre	$2	45 cents	$3 per acre.
22. Distance between the rows?	2 feet	26 inches	24 inches	20 inches	20 inches.
23. Distance between the roots?	½ foot	8 inches	6 inches	6 to 8 inches	8 inches.
24. Was stable manure applied to the crops?	Rockweed and dirt	Yes	Yes; 3 cords per ½ acre	Yes; before planting	Yes; $10.
25. When, and in what quantity per acre?	8 cords, $32	10 cords per acre; $50	May 13; $21	5 loads ashes	20 loads per acre.
26. Was artificial manure applied?	Yes; ground bone, ashes, and plaster.	Yes; 500 pounds	Yes; hen manure		
27. When; how; what; how much; cost?	Cost, $7	Phosphate; $12	In drills; $5	$24	
28. Time of first hoeing?	Middle of June	June 1	June 15	June 5	June 16.
29. Done by hand or horse cultivator?	By hand	Hand	Both	By hand	By hand.
30. If special implement used, describe it		No			
31. Cost of first hoeing?	$10	$2.50	$4	$3	$4 per acre.
32. Area hoed by each laborer per day?	⅓ acre	¼ acre	½ acre	½ acre	¼ acre.
33. Wages of laborers, by day or month?	$1 per day	$16 per month and board	$1 per day	$1 per day	$15 per month and board.
34. Time and cost of second hoeing?	Same as first	June; $2.50	June 25; $3	June 16	July 10; $4 per acre.
35. Date and cost of third hoeing?	do		June 20; $3	June 28; $7.50	
36. Date and cost of thinning?			June 25		July 25; $5 per acre.
37. How was thinning done; by hand, hoe, or special implement for the purpose?	By hand	Hand and hoe	By hand	Hand	Hand and hoe.
38. Time of harvesting?	October 1 to 10	October 24 and 25	October 15	October 18	October 10.
39. Mode of pulling, by hand or with instrument?	By hand	By hand	By hand	By hand	Hand and spade.

40. Surface pulled by each man per day?	$\frac{1}{10}$ acre, pulled and topped	$\frac{1}{2}$ acre	$\frac{1}{4}$ acre	$\frac{1}{4}$ acre	$\frac{1}{4}$ acre.
41. Mode of removing leaves or tops; by hand or with knife?	Knife	Knife	Knife	Knife	Knife.
42. Quantity topped by each laborer per day?	1 ton	$\frac{1}{4}$ acre	$\frac{1}{4}$ acre	3 tons	2 tons.
43. Total cost of harvesting per acre?	$16		$10	$9.15	$8 per acre.
44. Per ton of roots?				80 cents	
45. Distance of crop from station, wharf, or factory?		$\frac{1}{2}$ mile from depot	1 mile from station	2 miles	4 miles.
46. Cost of delivering?	75 cents per ton		Included in harvesting	75 cents per ton	50 cents per ton.
47. Price received per ton of beets?	$6	$5 per ton	$5	$5	$5.
48. Are beets preserved in trenches?	Yes			No	Yes.
49. How long?	Several months				Until April.
50. Cost of preparing trenches?					About 25 cents per ton.
51. Pulp, how obtained?					At factory or by railroad.
52. Price of pulp at the factory?					$1 per ton.
53. Cost delivered on farm?					$1.80 at railroad station.
54. Estimated feeding value as compared with hay or corn fodder?					
55. Mode of preserving?					
56. Cost of same?					
57. Mode of feeding?					
58. To what animals fed?					
59. Quantity per day per head?					
60. What percentage of sugar in your beets?					
61. What is their average size and yield per acre?	Size about 3 pounds		2 to 7 pounds	$\frac{1}{2}$ to 6 pounds	2 pounds.
62. Place of beets in your rotation of crops?					
63. Cost of culture per acre:					
a. Of beets?	$115.55*	$77.40 (not complete)	$75.20	$67.50	$53.40.
b. Of corn?					
c. Of potatoes?					
64. Value of crops per acre:					
a. Of beets?	$102	$75	$65	$80	$75.
b. Of corn?					
c. Of potatoes?					
65. Average yield per acre:					
a. Of beets; tons?	17 tons per acre	15 tons per acre	13 tons	16 tons	15 tons.
b. Of corn; bushels?					
c. Of potatoes; bushels?					

* Improvement to land worth $25—grower's estimate.

CONDITION OF SUGAR-BEET CULTURE IN MAINE—Continued.

Number of entry	116	117	118	119	120
1. Kind of seed sown?	Beet seed		Sugar-beet seed	Sugar beet	Sugar beet.
2. Source of same?	Maine Beet Sugar Co.	French sugar beet	Imported	Germany	Maine Beet Sugar Co.
3. Quantity sown per acre?	6 pounds	9 pounds	10 pounds	10 pounds	6 pounds.
3a. Cost of same?	$1.20	$1.80	$2	$2	$1.20.
4. Location of field, upland or lowland?	Sandy loam	Level	Upland	Upland	Upland and lowland.
5. Is your soil sand, limestone, clay, slate, or loam?		Sandy loam	Black loam	Slate	Sandy and black soil.
6. Is it well drained?	Yes	Yes	None needed	Yes	Yes.
7. Is the drainage natural or artificial?		Natural	Natural	Natural	Natural.
8. Area planted in sugar beets?	⅓ acre	1 acre	½ acre	1 acre	½ acre.
9. Crop on same land previous year?	Grass	None		Beets and corn	Beets and potatoes.
10. Time of first plowing?	May 20	Last of April	May 1	Fall of 1878	Fall of 1878.
11. Depth of same?	12 inches	10 inches	8 inches	8 inches	8 to 10 inches.
12. Cost of same per acre?	$5		$3	$2	$1.50.
13. Time of second plowing?		May 10	Plowed but once	May 10, 1879	May.
14. Depth of same?		10 inches		8 inches	
15. Cost of same?		$4; plowing twice		$2	$1.50 per acre.
16. Was subsoil plowing employed?	No	No	No	No	No.
17. Depth of same?					
18. Note other operations of preparation of the soil and cost of same.	Harrowed in the dressing		Harrowing; $1	Harrowing; $1	Harrowing; 50 cents per acre.
19. Planting, date?	May 23	May 20	May 3	May 15, 1879	May 30.
20. Method of—by hand or drill?	By hand	Hand	With machine	Drill	By hand.
21. Cost of planting?	$5 per acre		$1	$8	$2.50 per acre.
22. Distance between the rows?	27 inches	2 feet	10 and 20 inches	2 feet	33 inches.
23. Distance between the roots?	8 inches	10 inches	6 inches	8 inches	8 inches.
24. Was stable manure applied to the crops?	Yes; 12 cords per acre	Yes; 15 cords; $45	Yes	Yes; May 15, 1879	Yes; in spring.
25. When, and in what quantity per acre?	$24	April	6 cords; $18	$4.50	8 cords per acre; $16.
26. Was artificial manure applied?		No	No	Yes	Yes; before planting.
27. When; how; what; how much; cost?				Bradley's; $10	400 pounds; $10.
28. Time of first hoeing?	June 10	June 15	May 25	June 1	June 25.
29. Done by hand or horse cultivator?	By hand	Hand	By hand	Both	Hand.
30. If special implement used, describe it			None		
31. Cost of first hoeing?	$3		$4 per acre	$7.37	$2 per acre.
32. Area hoed by each laborer per day?	⅓ acre		40 square rods		¼ acre.
33. Wages of laborers, by day or month?	$1	75 cents	$8 per month	75 cents per day	50 cents per day.
34. Time and cost of second hoeing?	July; $10		June 20; $4 per acre	June 25; $5.50	July 5; $4 per acre.
35. Date and cost of third hoeing?	July 12; $5	July 1	July 10; $2	August 20; $4	July; $2 per acre.
36. Date and cost of thinning?		July			July 5; $2 per acre.
37. How was thinning done; by hand, hoe, or special implement for the purpose?	By hand	Hand	By hand	By hand	Hoe and hand.
38. Time of harvesting?	October 20 and 21	October 15	October 15	October 15	October 16 and 20.
39. Mode of pulling, by hand or with instrument?	By hand	By hand	By hand	By hand	By hand.
40. Surface pulled by each man per day?	¼ acre		⅛ acre		¼ acre.

41. Mode of removing leaves or tops; by hand or with knife?	Knife	Knife	Knife	Knife	Knife.
42. Quantity topped by each laborer per day?	¼ acre		2 tons		2 tons.
43. Total cost of harvesting per acre?	$8	$16	$5	$12	$4.50.
44. Per ton of roots?		16 tons	50 cents		50 cents.
45. Distance of crop from station, wharf, or factory?	100 rods	5 miles	3 miles from station	2 miles from station	2 miles from station.
46. Cost of delivering?	$2 per acre	$1.50 per ton	$1 per ton	50 cents per ton	50 cents per ton.
47. Price received per ton of beets?	$5	$5	$5	$5	$5.
48. Are beets preserved in trenches?			No		
49. How long?					
50. Cost of preparing trenches?					
51. Pulp, how obtained?					
52. Price of pulp at the factory?					
53. Cost delivered on farm?					
54. Estimated feeding value as compared with hay or corn fodder?					
55. Mode of preserving?					
56. Cost of same?					
57. Mode of feeding?					
58. To what animals fed?					
59. Quantity per day per head?					
60. What percentage of sugar in your beets?					
61. What is their average size and yield per acre?			2 pounds		3 inches in diameter.
62. Place of beets in your rotation of crops?			First		
63. Cost of culture per acre:					
a. Of beets?	$63.20		$52	$65.12	$57.50.
b. Of corn?					
c. Of potatoes?					
64. Value of crops per acre:					
a. Of beets?	$80	$80	$60	$67.50	$100.
b. Of corn?					
c. Of potatoes?					
65. Average yield per acre:					
a. Of beets; tons?	16 tons	16 tons	12 tons	13½ tons	20 tons.
b. Of corn; bushels?					
c. Of potatoes; bushels?					

CONDITION OF SUGAR-BEET CULTURE IN MAINE—Continued.

Number of entry	121	122	123	124	125
1. Kind of seed sown?	Sugar beet		French sugar beet	Sugar beet	
2. Source of same?	Germany	Maine Beet Sugar Co.	Maine Beet Sugar Co	Germany	Germany.
3. Quantity sown per acre?	7 pounds	10 pounds	8 pounds per acre	8 pounds	14 pounds.
3a. Cost of same?	$1.40	$2	$1.60	$1.60	$2.80.
4. Location of field, upland or lowland?	Upland	Upland	Upland	Upland	Upland.
5. Is your soil sand, limestone, clay, slate, or loam?	Sand and rocky	Sandy loam	Slate	Sandy loam	Sandy loam.
6. Is it well drained?	Yes	Yes	Yes	Yes	Yes.
7. Is the drainage natural or artificial?	Natural	Natural	Natural	Natural	Natural.
8. Area planted in sugar beets?	⅜ acre	1 acre	½ acre	100 square rods	½ acre.
9. Crop on same land previous year?	Potatoes	Corn	Potatoes	Corn and potatoes	Potatoes.
10. Time of first plowing?	Fall	Fall	Fall, 1877; spring, 1879	1st of May	May 13.
11. Depth of same?	7 or 8 inches	7 inches	6 inches	6 inches	10 inches.
12. Cost of same per acre?	$4.50	$4		$2	About $3 per acre.
13. Time of second plowing?		Spring	Spring, 1879	Plowed only once	
14. Depth of same?		10 inches	6 inches		
15. Cost of same?		$4	$3 per acre		
16. Was subsoil plowing employed?	No	No	No	No	No.
17. Depth of same?					
18. Note other operations of preparation of the soil, and cost of same.		Harrowing, &c.; $9		Harrowed well; $1	
19. Planting, date?	May 7 to 14	May 10 to 18	About May 10	1st of May	May 20 to 23.
20. Method of—by hand or drill?	By hand	Drill	By hand	By hand	By han .
21. Cost of planting?	$6	$2	$4 per acre	$6 per acre	About $6.
22. Distance between the rows?	2½ feet	3 feet	22 inches	3 feet	2 feet.
23. Distance between the roots?	8 inches	8 inches	8 inches	8 inches	8 inches.
24. Was stable manure applied to the crops?	Yes	Yes; time of planting	Yes; 6 cords; $12	Yes; 9 cords to ½ acre	Barn-yard manure.
25. When, and in what quantity per acre?	17 loads; cost $12	6 cords; $12		$36	6 cords; $12.
26. Was artificial manure applied?	Yes; Stockbridge's	Yes; Stockbridge's and Bradley's.	Yes; $20 per acre	Yes; Bradley's	
27. When; how; what; how much; cost?	400 pounds; cost, $10	375 pounds; cost, $9.53	Stockbridge fertilizer	200 pounds per acre; $5	
28. Time of first hoeing?	First part of June	1st of June	June 1		June 27.
29. Done by hand or horse cultivator?	Hand and horse	Both	By hand	By hand	By hand.
30. If special implement used, describe it					
31. Cost of first hoeing?	$8	$4	$8 per acre	$6	$3.
32. Area hoed by each laborer per day?		¼ acre	⅛ acre	16 square rods	
33. Wages of laborers, by day or month?		$1 per day	$1 per day	$1 per day	
34. Time and cost of second hoeing?	July	Middle of June; $4	June 20; $8 per acre	June 1; $3	
35. Date and cost of third hoeing?	August	Last of June; $4	July 5; $6 per acre		
36. Date and cost of thinning?		Middle of June; $6		June 1; $2	$2 per acre.
37. How was thinning done; by hand, hoe, or special implement for the purpose?		Hand and hoe	Both	Hand	By hand.
38. Time of harvesting?	October 30	Middle of October	October 15	October	October 28 and 30.

39. Mode of pulling, by hand or with instrument?	By hand	By hand	By hand	By hand	By hand.
40. Surface pulled by each man per day?		⅓ acre	¼ acre per day		
41. Mode of removing leaves or tops, by hand or with knife?		Knife	Knife	Knife	Knife.
42. Quantity topped by each laborer per day?	Topped ¾ acre	⅙ acre	¼ acre	50 bushels	
43. Total cost of harvesting per acre?	$6	$12	$8 per acre	$14	$4 per acre.
44. Per ton of roots?		$1.50	16 tons		
45. Distance of crop from station, wharf, or factory?	3 miles	1½ miles	1 mile	6 miles from wharf	8 miles.
46. Cost of delivering?	$2 per ton		50 cents per ton	$1 per ton	About $2.
47. Price received per ton of beets?	$5	$5	$5 per ton	$5	$6 per ton.
48. Are beets preserved in trenches?			Yes		
49. How long?					
50. Cost of preparing trenches?			About 50 cents per ton		
51. Pulp, how obtained?			From beet sugar comp'y.		
52. Price of pulp at the factory?			$1 per ton		
53. Cost delivered on farm?			$2		
54. Estimated feeding value as compared with hay or corn-fodder?					
55. Mode of preserving?					
56. Cost of same?					
57. Mode of feeding?					
58. To what animals fed?					
59. Quantity per day per head?					
60. What percentage of sugar in your beets?					
61. What is their average size and yield per acre?		14 tons		Size, 3 pounds; yield, 18 tons.	
62. Place of beets in your rotation of crops?		After corn			
63. Cost of culture per acre:					
a. Of beets?	$55.90	$74.53	$78.60	$94.60	$34.80.
b. Of corn?					
c. Of potatoes?					
64. Value of crops per acre:					
a. Of beets?	$20	$70	$80	$90	$48.
b. Of corn?					
c. Of potatoes?					
65. Average yield per acre:					
a. Of beets, tons?	4 tons	14 tons	16 tons	18 tons	8 tons.
b. Of corn, bushels?					
c. Of potatoes, bushels?					

CONDITION OF SUGAR-BEET CULTURE IN MAINE—Continued.

Number of entry	126	127	128	129	130
1. Kind of seed sown?	Sugar beet	Sugar beet	White sugar beet	Sugar beet	White sugar beet.
2. Source of same?	Germany		Maine Beet Sugar Co.		Portland.
3. Quantity sown per acre?	8 pounds	14 pounds	14 pounds per acre	8 quarts per acre	3 quarts.
3a. Cost of same?	$1.60	$2.80	$2.80		
4. Location of field, upland or lowland?	Sandy loam	Upland	Swamp	Upland	Lowland.
5. Is your soil sand, limestone, clay, slate, or loam?		Loam	Stiff clay	Loam	Loam.
6. Is it well drained?	Yes	Yes		Yes	
7. Is the drainage natural or artificial?	Natural	Artificial	Artificial	Natural	Artificial, partly.
8. Area planted in sugar beets?	About 1 acre	½ acre	½ acre	1 acre	½ acre.
9. Crop on same land previous year?	Corn	Corn and beets	Potatoes	Corn	Corn.
10. Time of first plowing?	Fall	May 10	Fall, 1878	May 1	May.
11. Depth of same?	8 inches	10 inches	½ foot	10 inches	8 inches.
12. Cost of same per acre?	$1.50	$3	$3	$1	$2.
13. Time of second plowing?	April		May 12	May 1	None.
14. Depth of same?	8 inches		½ foot	$1	Do.
15. Cost of same?			$3 per acre	10 inches	Do.
16. Was subsoil plowing employed?	No	No	No	No	No.
17. Depth of same?					
18. Note other operations of preparation of the soil, and cost of same.	50 cents			About $1	Harrowed.
19. Planting, date?	May 15	May 20	May 20	May 10	
20. Method of—by hand or drill?	By hand	By hand	By hand	By hand	Drill.
21. Cost of planting?	$1.50		$6 per acre	About $2	$2.
22. Distance between the rows?	20 inches	2½ feet	12 inches	24 inches	3 feet.
23. Distance between the roots?	8 inches	6 to 8 inches	4 and 8 inches	14 inches	4 to 8 inches.
24. Was stable manure applied to the crops?	Yes	Yes; in spring	Yes; 2 cords per acre	Yes	Yes.
25. When, and in what quantity per acre?	4 cords; cost $12	4 cords; $12	$6	10 cords per acre	Spring.
26. Was artificial manure applied?	Yes; 200 lbs. phosphate.	Yes; 200 pounds in drill.	Yes; 200 pounds; $5	No	Yes; at planting.
27. When; how; what; how much; cost?	$5	$5	Stockbridge fertilizer		200 pounds phosphate; $5.
28. Time of first hoeing?		June 30		June 1	June.
29. Done by hand or horse cultivator?	By hand	Both	By hand		Both.
30. If special implement used, describe it.					
31. Cost of first hoeing?	$1	$5	$6 per acre	$6	$5.
32. Area hoed by each laborer per day?		¼ acre	⅙ acre		⅓ acre.
33. Wages of laborers, by day or month?			$1.50 per day		
34. Time and cost of second hoeing?	$5	Augnst; $2	June 30; $3	$6	
35. Date and cost of third hoeing?	$2	August	August 1; $3		
36. Date and cost of thinning?					July.
37. How was thinning done; by hand, hoe, or special implement for the purpose?	By hand	By hand	By hand	Hand and hoe	Hand.
38. Time of harvesting?	October	October 22	November 1.	October 20	November 1.
39. Mode of pulling, by hand or with instrument?		By hand	By hand	By hand	Hand.
40. Surface pulled by each man per day?		½ acre	¼ acre	¼ acre	¼ acre.

41. Mode of removing leaves or tops, by hand or with knife?	Knife	By hand	By hand	Knife	Knife.
42. Quantity topped by each laborer per day?	¼ acre	¼ acre	2 tons		1 cart-load.
43. Total cost of harvesting per acre?	$5	$15	$15	$20	$12 per acre.
44. Per ton of roots?					
45. Distance of crop from station, wharf, or factory?	2 miles	½ mile	2½ miles	7 miles	1 mile.
46. Cost of delivering?	50 cents per ton	$3 per acre	$1 per ton	$1 per ton	$3 per acre.
47. Price received per ton of beets?	$5	$5	$5	$5	$5.
48. Are beets preserved in trenches?					
49. How long?					
50. Cost of preparing trenches?					
51. Pulp, how obtained?					
52. Price of pulp at the factory?					
53. Cost delivered on farm?					
54. Estimated feeding value as compared with hay or corn fodder?					
55. Mode of preserving?					
56. Cost of same?					
57. Mode of feeding?					
58. To what animals fed?					
59. Quantity per day per head?					
60. What percentage of sugar in your beets?					
61. What is their average size and yield per acre?	16 tons	Size, 2 pounds; yield, 15 tons.	15 tons	10 tons	10 tons.
62. Place of beets in your rotation of crops?					
63. Cost of culture per acre:					
a. Of beets?	$43.10	$47.80	$61.80	$47*	$29.*
b. Of corn?					
c. Of potatoes?					
64. Value of crops per acre:					
a. Of beets?	$80	$75	$75	$50	$50.
b. Of corn?					
c. Of potatoes?					
65. Average yield per acre:					
a. Of beets; tons?	16 tons	15 tons	15 tons	10 tons	10 tons.
b. Of corn; bushels?					
c. Of potatoes; bushels?					

* Not including stable manure and seed.

CONDITION OF SUGAR-BEET CULTURE IN MAINE—Continued.

Number of entry	131	132	133	134	135
1. Kind of seed sown?	Sugar beet	Sugar beet	Imported sugar beet	White sugar beet	
2. Source of same?	Maine Beet Sugar Co		Maine Beet Sugar Co	Germany	Maine Beet Sugar Co.
3. Quantity sown per acre?	14 pounds	8 pounds	14 pounds per acre	14 pounds	13 pounds.
3a. Cost of same?	$2.80	$1.60	$2.80	$2.80	$2.60.
4. Location of field upland or lowland?	Upland	Clay loam	Upland	Upland	Upland.
5. Is your soil sand, limestone, clay, slate, or loam?	Loam		Loam	Loam	Loam.
6. Is it well drained?	Yes		Yes	Yes	Yes.
7. Is the drainage natural or artificial?	Natural	Natural	Natural	Natural	Natural.
8. Area planted in sugar beets?	1 acre		½ acre	¼ acre	1 acre.
9. Crop on same land previous year?	Potatoes	Corn	Potatoes	Onions	Indian corn.
10. Time of first plowing?	May 8	Fall	August 7, 1877	About May 20	Middle of May.
11. Depth of same?	8 or 10 inches	6 inches	10 inches	7 inches	8 inches.
12. Cost of same per acre?	$3	$4.50	$3.50 per acre	$2 per acre	$1.50.
13. Time of second plowing?		May 20	May 15, 1878		
14. Depth of same?		6 inches	10 inches		
15. Cost of same?		$2	$2.50 per acre		
16. Was subsoil plowing employed?	No		Yes	No	
17. Depth of same?			18 inches		
18. Note other operations of preparation of the soil, and cost of same.		Harrowed; $2	Harrowed; $2		Harrowed, &c.; 75 cents.
19. Planting, date?	May 12	May 24	May 16	June 1	May 18.
20. Method of—by hand or drill?	Drill	Hand	By hand	Hand	By hand.
21. Cost of planting?	$12 to $15	$5	$1.50	$6 per acre	$3.75.
22. Distance between the rows?	20 inches	2 feet	18 inches	26 inches	30 inches.
23. Distance between the roots?	5 to 10 inches	6 inches	8 inches	6 inches	7 inches.
24. Was stable manure applied to the crops?	Yes. Barn yard	Yes		Yes	Yes; harrowed in.
25. When, and in what quantity per acre?	8 cords	10 cords; $30		4 cords; $20	12 cords.
26. Was artificial manure applied?	Yes; 100 pounds		Yes; Stockbridge's	Yes; Stockbridge	Yes; leached ashes; $15.
27. When; how; what; how much; cost?	$3		$10 per acre	$10 per acre	Stockbridge; $10.
28. Time of first hoeing?	June 1		June 26	June 15	June 1.
29. Done by hand or horse cultivator?	Both		Both	Hand	Horse cultivator.
30. If special implement used, describe it					
31. Cost of first hoeing?	$12	$10	$3	$2.50	60 cents.
32. Area hoed by each laborer per day?	⅓ acre		¼ acre	⅛ acre	
33. Wages of laborers, by day or month?					
34. Time and cost of second hoeing?	June 1; $8	July 25; $6	July 12; $1.50	$2	$1.20.
35. Date and cost of third hoeing?			August 4; $2		
36. Date and cost of thinning?			July 12; $26		June 7; $18.
37. How was thinning done; by hand, hoe, or special implement for the purpose?	By hand	By hand	By hand	Hand	By hand.
38. Time of harvesting?	October 24	October 21	October 20	October 20	October 15.
39. Mode of pulling, by hand or with instrument?	By hand	By hand	By hand	Fork	By hand.

40. Surface pulled by each man per day?	¼ acre		⅛ acre	⅓ acre	¼ acre.
41. Mode of removing leaves or tops; by hand or with knife?	Knife	Knife	Knife	Hand	By hand.
42. Quantity topped by each laborer per day?	4 tons			⅓ acre	¼ acre.
43. Total cost of harvesting per acre?	$9	$10	$10 per acre	$12 per acre	$10.
44. Per ton of roots?					
45. Distance of crop from station, wharf, or factory?	3½ miles from station	4 miles	4 miles	4 miles	2 miles.
46. Cost of delivering?	$1 per ton	$12 per acre	$3.50 per acre (?)	$1 per ton	$10 per acre.
47. Price received per ton of beets?	$5	$5	$5	$5	$5.
48. Are beets preserved in trenches?					
49. How long?					
50. Cost of preparing trenches?					
51. Pulp, how obtained?					
52. Price of pulp at the factory?					
53. Cost delivered on farm?					
54. Estimated feeding value as compared with hay or corn fodder?					
55. Mode of preserving?					
56. Cost of same?					
57. Mode of feeding?					
58. To what animals fed?					
59. Quantity per day per head?					
60. What percentage of sugar in your beets?			90 pounds per ton		
61. What is their average size and yield per acre?	12½ tons	12 tons	13 tons	8 tons per acre	20 tons.
62. Place of beets in your rotation of crops?					
63. Cost of culture per acre:					
a. Of beets?	$66.30*	$83.10	$68.30	$65.30	$73.40.*
b. Of corn?					
c. Of potatoes?					
64. Value of crops per acre:					
a. Of beets?	$62.50	$60	$65	$40	$100.
b. Of corn?					
c. Of potatoes?					
65. Average yield per acre:					
a. Of beets; tons?	12½ tons	12 tons	13 tons	8 tons	20 tons.
b. Of corn; bushels?					
c. Of potatoes; bushels?					

*Not including stable manure.

CONDITION OF SUGAR-BEET CULTURE IN MAINE—Continued.

Number of entry	136	137	138	139	140
1. Kind of seed sown?	White beet	Sugar beet	Sugar beet	Sugar beet	Sugar beet.
2. Source of same?		Portland		France	Portland.
3. Quantity sown per acre?		14 pounds	10 pounds	8 pounds	14 pounds.
3a. Cost of same?		$2.80	$2	$1.60	$2.80.
4. Location of field, upland or lowland?	Lowland	Upland	Lowland		Upland.
5. Is your soil sand, limestone, clay, slate, or loam?	Black loam	Loam	Loam	Loam	Loam.
6. Is it well drained?	Yes	Yes	Yes	No	Southeast slope.
7. Is the drainage natural or artificial?	Artificial	Natural	Natural		Natural.
8. Area planted in sugar beets?	½ acre	¼ acre	⅓ acre	⅔ of an acre	¼ acre.
9. Crop on same land previous year?	Corn	Corn	Potatoes	Potatoes and grass	Corn.
10. Time of first plowing?	May 1	May	May 6	Only once, May 19	May.
11. Depth of same?	8 inches	4 and 5 inches	5 inches	10 inches	8 inches.
12. Cost of same per acre?		$3	$2.50	$5	$5.
13. Time of second plowing?			May 10		
14. Depth of same?			$4.50		
15. Cost of same?			No		
16. Was subsoil plowing employed?				No	No.
17. Depth of same?					
18. Note other operations of preparation of the soil, and cost of same.		$1		Harrowing, &c., $8	Harrowed, &c., $2 per acre.
19. Planting, date	May 31	June 2	May 22	May 24	May.
20. Method of—by hand or drill?	By hand	Hand	Drill	Drill	
21. Cost of planting?	$4	$1	$1.50	$1	$6 per acre.
22. Distance between the rows?	30 inches	18 inches	3 feet	1½ feet	2½ feet.
23. Distance between the roots?	10 inches	8 inches	½ foot	10 inches	8 inches.
24. Was stable manure applied to the crops?	Yes; cost $15	Yes	Yes; cost $24	Yes	Yes; in May.
25. When, and in what quantity per acre?		7 cords; $35	May 14; 6 cords per acre.	May 22; 10 cords; $50	6 cords, $12.
26. Was artificial manure applied?	No	No	Yes; Stockbridge's	No	Yes.
27. When; how; what; how much; cost?			250 pounds per ½ acre; $5		$10.
28. Time of first hoeing?	June 19	July 15	June 21	Last of June	Middle of June.
29. Done by hand or horse cultivator?	By hand	Hand	Both	Hand	Horse cultivator.
30. If special implement used, describe it?					
31. Cost of first hoeing?	$5	$1	$6	$10	$2.
32. Area hoed by each laborer per day?			⅓ acre		⅓ acre.
33. Wages of laborers, by day or month?		$1 per day	$15 per month	$12 to $15 per month	$1 per day.
34. Time and cost of second hoeing?	July 9; $8		July 14	10 days, $7.50	$8 per acre.
35. Date and cost of third hoeing?	July 30; $10				Do.
36. Date and cost of thinning?		$1			Do.
37. How was thinning done; by hand, hoe, or special implement for the purpose?	By hand	Hard	Both	Both	Hand.
38. Time of harvesting?	September 10	October	October	Last of October	Last of October.
39. Mode of pulling, by hand or with instrument?	By hand	Hand	Hand	Hand	Spade.
40. Surface pulled by each man per day?			¼ acre	16 rods	¼ acre.

41. Mode of removing leaves or tops; by hand or with knife?	Knife	Knife	Knife	Knife	Knife.
42. Quantity topped by each laborer per day?			¼ acre		⅛ acre.
43. Total cost of harvesting per acre?	$20	$12 per acre	$8	$15	$12.
44. Per ton of roots?	$5				
45. Distance of crop from station, wharf, or factory?	2 miles	4 miles	2 miles	3 miles	1½ miles from station.
46. Cost of delivering?		$1 per ton		75 cents per ton	75 cents per ton.
47. Price received per ton of beets?	$5	$5	$5	$5	$5.
48. Are beets preserved in trenches?					
49. How long?					
50. Cost of preparing trenches?					
51. Pulp, how obtained?					
52. Price of pulp at the factory?					
53. Cost delivered on farm?					
54. Estimated feeding value as compared with hay or corn fodder?					
55. Mode of preserving?					
56. Cost of same					
57. Mode of feeding?					
58. To what animals fed?					
59. Quantity per day per head?					
60. What percentage of sugar in your beets?					
61. What is their average size and yield per acre?	3 pounds; 8 tons	12 tons	12 tons	20 tons	16 tons.
62. Place of beets in your rotation of crops?					
63. Cost of culture per acre:					
a. Of beets?		$58.80 per acre	$58.50 per acre	$113.10	$87.80.
b. Of corn?					$49.
c. Of potatoes?					$45.
64. Value of crops per acre:					
a. Of beets?	$40	$60	$60	$100	$80.
b. Of corn?					$28.
c. Of potatoes?					$40.
65. Average yield per acre:					
a. Of beets; tons?	8 tons	12 tons		20 tons	16 tons.
b. Of corn; bushels?					40 bushels.
c. Of potatoes; bushels?					100 bushels.

CONDITION OF SUGAR-BEET CULTURE IN MAINE—Continued.

Number of entry	141	142	143	144	145
1. Kind of seed sown?		Sugar beet	Sugar beet	Sugar beet	
2. Source of same?	Maine Beet Sugar Co	Germany	Portland	Portland	Maine Beet Sugar Co.
3. Quantity sown per acre?	11 pounds	10 pounds	14 pounds	7 pounds	12 pounds.
3a. Cost of same?	$2.20	$2	$2.80	$1.40	$2.40.
4. Location of field, upland or lowland?	Upland	Upland	Upland	Upland	Upland.
5. Is your soil sand, limestone, clay, slate, or loam?	Clay loam	Slightly clay	Loam	Gravelly loam	Sandy loam.
6. Is it well drained?	Yes	Yes	Yes	No	
7. Is the drainage natural or artificial?	Artificial	Natural	Natural	Artificial	Natural.
8. Area planted in sugar beets?	1 acre	¾ acre	½ acre	2 acres	1 acre.
9. Crop on same land previous year?	Potatoes	Hay	Corn	Corn and potatoes	Potatoes.
10. Time of first plowing?	Last of May	Only once, May 20	Spring, 1878	September	May.
11. Depth of same?	12 inches	8 inches	7 inches	8 inches	8 inches.
12. Cost of same per acre?	$4	$3	$4 per acre	$3	$4.50 per acre.
13. Time of second plowing?	Last of May		Spring, 1879		May 15.
14. Depth of same?	8 inches		7 inches	10 inches	8 inches.
15. Cost of same?	$3		$2.50 per acre	$2	$2.
16. Was subsoil plowing employed?	No	No	No		
17. Depth of same?				10 inches	
18. Note other operations of preparation of the soil, and cost of same.	Harrowing, &c.; $1	Harrowing, &c.; $2 per acre.	Harrowed only	Harrowed, &c.; 75 cents.	Harrowing; 75 cents.
19. Planting, date?	May 31	May 27	May 17	May 15	May 25.
20. Method of—by hand or drill?	Drill	Drill	Drill	Drill	Hand.
21. Cost of planting?	$2	$4 per acre	$5	$2	$8.
22. Distance between the rows?	18 inches	3 feet	32 inches	24 inches	2½ feet.
23. Distance between the roots?	6 inches	4 to 8 inches	8 to 10 inches	8 inches	6 to 8 inches.
24. Was stable manure applied to the crops?	Yes	No	Yes; 2 cords per ¼ acre	Yes; 6 cords	Stable manure.
25. When, and in what quantity per acre?	Last of May		$32 per acre	Plowed in; $18	6 cords; $24.
26. Was artificial manure applied?	20 cords	Yes; Stockbridge's & Bradley's.	Yes; Stockbridge	Yes; Stockbridge's & Bradley's.	
27. When; how; what; how much? cost?	No	$20	$5	$20	
28. Time of first hoeing?	Last of June	Middle of June	June 25		Last of June.
29. Done by hand or horse cultivator?	By hand	Both	Horse cultivator	Cultivator	Hand.
30. If special implement used, describe it.					
31. Cost of first hoeing?	$15	$4 per acre	$4	50 cents	$6.
32. Area hoed by each laborer per day?			½ acre		½ acre.
33. Wages of laborers, by day or month?			$1 per day	$14 per month	75 cents per day.
34. Time and cost of second hoeing?	Last of August; $20	July 1; $3 per acre	July 20 to 25	$1 per acre	$6.
35. Date and cost of third hoeing?				$1 per acre	$5.
36. Date and cost of thinning?	Last of July; $15	Last of June; $8 pr. acre		$6	
37. How was thinning done; by hand, hoe, or special implement for the purpose?	Hand	Hand	By hand	Hand	By hand.
38. Time of harvesting?	October	October	October 17	October	October 20.
39. Mode of pulling, by hand or with instrument?	By hand	Hand	By hand		Hand.

40. Surface pulled by each man per day?		¼ acre	⅛ acre	½ acre	¼ acre.
41. Mode of removing leaves or tops; by hand or with knife?	Knife	Knife	Knife	Knife	Knife.
42. Quantity topped by each laborer per day?		About 1 ton		2 tons	¼ acre.
43. Total cost of harvesting per acre?	$12	$8	$5 per ½ acre	$10	$6.
44. Per ton of roots?	$1.85	$2			
45. Distance of crop from station, wharf, or factory?	3½ miles	2 miles	1 mile	1½ miles	3 miles; railroad station.
46. Cost of delivering?	$8 per acre	$1 per ton	50 cents per ton	$5 per acre	$10 per acre.
47. Price received per ton of beets?	$5	$5	$5	$5 per ton	$5.
48. Are beets preserved in trenches?	No				
49. How long?					
50. Cost of preparing trenches?					
51. Pulp, how obtained?					
52. Price of pulp at the factory?					
53. Cost delivered on farm?					
54. Estimated feeding value as compared with hay or corn fodder?					
55. Mode of preserving?					
56. Cost of same?					
57. Mode of feeding?					
58. To what animals fed?					
59. Quantity per day per head?					
60. What percentage of sugar in your beets?					
61. What is their average size and yield per acre?	9 tons	4 tons	1½ pounds; 15 tons	13 tons	
62. Place of beets in your rotation of crops?					
63. Cost of culture per acre:					
a. Of beets?	$82.20*	$58	$74.80	$70.65	$74.65.
b. Of corn?					$63.
c. Of potatoes?					$48.25.
64. Value of crops per acre:					
a. Of beets?	$45	$20	$75	$65	$80.
b. Of corn?					
c. Of potatoes?					
65. Average yield per acre:					
a. Of beets; tons?					16 tons.
b. Of corn; bushels?					
c. Of potatoes; bushels?					

*Not including stable manure.

CONDITION OF SUGAR-BEET CULTURE IN MAINE—Continued.

Number of entry	146	147	148	149	150
1. Kind of seed sown?	Red sugar beet		German sugar beet	Sugar beet	Sugar beet.
2. Source of same?	Imported	Maine Beet Sugar Co	Portland	Maine Beet Sugar Co	Germany.
3. Quantity sown per acre?	14 pounds	14 pounds	12 pounds	14 pounds	8 pounds per acre.
3a. Cost of same?	$2.80	$2.80	$2.40	$2.80	$1.60.
4. Location of field, upland or lowland?	Upland	Upland	Interval on rivor	Lowland	Rolling land.
5. Is your soil sand, limestone, clay, slate, or loam?	Loam	Loam	Sandy loam	Black loam	Clay loam.
6. Is it well drained?	Yes	Yes	Yes	Yes	Yes.
7. Is the drainage natural or artificial?	Natural	Natural	Natural	Artificial	Natural.
8. Area planted in sugar beets?	1 acre	1 acre	½ acre	½ acre	2 acres.
9. Crop on same land previous year?	Corn	Corn	Potatoes	Beets and potatoes	
10. Time of first plowing?	May	May 2	May 1, 1878	May 1	
11. Depth of same?	7 inches	9 inches	10 inches	About 9 inches	10 inches.
12. Cost of same per acre?	$2	$4	$2	$10 per acre	$5 per acre.
13. Time of second plowing?	May		May 1, 1879		
14. Depth of same?	8 inches		10 inches	6 inches	
15. Cost of same?	$2		$2 per acre	$3	
16. Was subsoil plowing employed?	No	No	No	No	
17. Depth of same?					
18. Note other operations of preparation of the soil, and cost of same.	$2	Harrowed; $2	Harrowing; $1 per acre	Harrowing; $1.50	Harrowing; $8, 2 acres.
19. Planting, date?	May 15	May 10	May 5		May 12.
20. Method of—by hand or drill?	Drill	By hand	By hand	By hand	By machine.
21. Cost of planting?	$6	$6	$3 per acre		$8 per 2 acres.
22. Distance between the rows?	24 inches	2 feet	20 inches	2 to 3 feet apart	28 inches.
23. Distance between the roots?	8 inches	8 inches	6 to 8 inches	6 to 8 inches	6 to 8 inches.
24. Was stable manure applied to the crops?	No	Yes; cost, $40	Yes; last of April	Stable manure	Yes; $32.50 per acre.
25. When, and in what quantity per acre?		May 1; 8 cords	12 cords per acre; $36	6 cords per acre; $24	
26. Was artificial manure applied?	Yes; Stockbridge's	No	Yes	No	Yes; superphosphate.
27. When; how; what; how much; cost?	In drills; 800 lbs; $20		Bradley's; 600 lbs. per acre. $13.50.		$18 per 2 acres.
28. Time of first hoeing?	May 28 to 31	June 1	June 1		June 10.
29. Done by hand or horse cultivator?	Horse	Both	Hand	Hand	By hand.
30. If special implement used, describe it					
31. Cost of first hoeing?	$1.50	$6	$5	$10 per acre	$6 per 2 acres.
32. Area hoed by each laborer per day?		⅛ acre	⅛ acre	⅒ acre per day	½ acre.
33. Wages of laborers, by day or month?		$1 per day	$1 per day	$1 per day	
34. Time and cost of second hoeing?	June 5; $5	June 15; $6	June 20; $4 per acre	$8	July 1; $9 per 2 acres.
35. Date and cost of third hoeing?	June 25; $6	July; $4	July 10; $4 per acre	$8	August 1; $6 per 2 acres.
36. Date and cost of thinning?	do	August; $2			June 21.
37. How was thinning done; by hand, hoe, or special implement for the purpose?	Hand and hoe	Hand and hoe	Both	By hand	Hand.
38. Time of harvesting?	October 18	October 25	October 22	October	October 12.
39. Mode of pulling, by hand or with instrument?	Hand	By hand	Hand	Hand	Hand and fork.

40. Surface pulled by each man per day?		⅓ acre	¼ acre	¼ acre	
41. Mode of removing leaves or tops; by hand or with knife?	Knife	Knife	Knife	Knife	Knife.
42. Quantity topped by each laborer per day?		⅓ acre	¼ acre		
43. Total cost of harvesting per acre?	$10	$6	$6	$10 per acre	$9 per 2 acres.
44. Per ton of roots?					
45. Distance of crop from station, wharf, or factory?	2 miles	3 miles	2 miles from station	5 miles	12 miles.
46. Cost of delivering?	$1 per ton	$10 per acre	50 cents per ton	$1.50 per ton	$1.50 per ton.
47. Price received per ton of beets?	$5	$5	$5	$5	$6.
48. Are beets preserved in trenches?					
49. How long?					
50. Cost of preparing trenches?					
51. Pulp, how obtained?			At station		
52. Price of pulp at the factory?		$1 per ton	$1 per ton		
53. Cost delivered on farm?		$3	$2 per ton		
54. Estimated feeding value as compared with hay or corn fodder?					
55. Mode of preserving?					
56. Cost of same?					
57. Mode of feeding?					
58. To what animals fed?					
59. Quantity per day per head?					
60. What percentage of sugar in your beets?					
61. What is their average size and yield per acre?			1 pound		20 tons for 2 acres.
62. Place of beets in your rotation of crops?					
63. Cost of culture per acre:					
a. Of beets?	$69.30	$88.80	$86.40	$86 30	$96.10.*
b. Of corn?					
c. Of potatoes?					
64. Value of crops per acre:					
a. Of beets?	$60	$75	$75	$30	$60 per acre.
b. Of corn?					
c. Of potatoes?					
65. Average yield per acre:					
a. Of beets; tons?	12 tons	15 tons per acre	15 tons	6 tons	10 tons.
b. Of corn; bushels?					
c. Of potatoes; bushels?					

*Cost of thinning not included.

CONDITION OF SUGAR-BEET CULTURE IN MAINE—Continued.

Number of entry	151	152	153	154	155
1. Kind of seed sown?	Sugar beet	Imported white	Sugar beet	Sugar-beet seed	Sugar beet.
2. Source of same?	Portland	Maine Beet Sugar Co	Maine Beet Sugar Co	Germany	Maine Beet Sugar Co.
3. Quantity sown per acre?	12 pounds	8 pounds	12 pounds	12 pounds	10 pounds.
3a. Cost of same?	$2.40	$1.60	$2.40	$2.40	$2.
4. Location of field, upland or lowland?	Lowland	Upland	Upland	Upland	Upland.
5. Is your soil sand, limestone, clay, slate, or loam?	Sand	Gravelly loam	Red loam	Sandy loam	Slate.
6. Is it well drained?	Yes	Yes	Yes	Yes	Yes.
7. Is the drainage natural or artificial?	Natural	Natural	Natural	Natural	Natural.
8. Area planted in sugar beets?	⅛ acre	⅛ acre	⅛ acre	½ acre	½ acre.
9. Crop on same land previous year?	Corn	Corn	Corn	Corn	Cabbage.
10. Time of first plowing?	May 17	Last of April	May 1	May 10	Fall.
11. Depth of same?	7 inches	7 inches	10 inches	7 inches	7 inches.
12. Cost of same per acre?	$3	$1.25	$3	$3	$4.
13. Time of second plowing?	May 15	May 15			May 5.
14. Depth of same?	8 inches	7 inches			8 inches.
15. Cost of same?	$2.50 per acre	$1.25			$2.
16. Was subsoil plowing employed?	No	No	No	No	No.
17. Depth of same?					
18. Note other operations of preparation of the soil, and cost of same.	Harrowing, &c.; $12.75	Harrowing, &c.; 50 cents	Harrowing; $1.50		Harrowing; $1.
19. Planting, date?		Middle of May	May 10	May 14	May 8.
20. Method of—by hand or drill?	Hand and drill	By hand	Machine	Hand	By hand.
21. Cost of planting?	$2	$3	50 cents per ⅛ acre	$3 per ⅛ acre	$1.
22. Distance between the rows?	2 feet	28 inches	18 inches	11 inches	2 feet.
23. Distance between the roots?	7 inches	8 inches	4 inches	8 inches	8 inches.
24. Was stable manure applied to the crops?	Yes	Yes	Yes; stable manure	Yes	Yes; in the spring.
25. When, and in what quantity per acre?	14 cords; $42	8 cords; $24	10 cords; $40	5 cords; $25	6 cords per acre; $18.
26. Was artificial manure applied?	Yes; phosphate	Yes		No	Yes; superphosphate.
27. When; how; what; how much; cost?	In drill; $16.25	Stockbridge; $10			500 pounds; $12.
28. Time of first hoeing?	June 16	May 16	Middle of June	June 10	Last of May.
29. Done by hand or horse cultivator?	Hand	Hand	Both	Both	Both.
30. If special implement used, describe it					
31. Cost of first hoeing?	$4	$1.50	$4	$8 per ⅛ acre	$3.
32. Area hoed by each laborer per day?	2/5 acre	⅛ acre		1/16 acre	¼ acre.
33. Wages of laborers, by day or month?				$1 per day	80 cents per day.
34. Time and cost of second hoeing?	$6.50	June 30; $1.50	$2	June 24	June; $3.
35. Date and cost of third hoeing?	$8				July; $3.
36. Date and cost of thinning?		June 30; $1.50			
37. How was thinning done; by hand, hoe, or special implement for the purpose?	Hand	Hand	Hand and hoe	Hand	Hand.
38. Time of harvesting?	October	October 25	2d week of October	Last of October	Last of October.
39. Mode of pulling, by hand or with instrument?	Hand	Hand	Both	By hand	Hand.
40. Surface pulled by each man per day?	⅛ acre	⅓ acre		¼ acre	⅛ acre per day.

41. Mode of removing leaves or tops; by hand or with knife?	Knife	Knife	Both	Knife	Knife.
42. Quantity topped by each laborer per day?	1 ton	1½ tons		⅓ ton	1 ton.
43. Total cost of harvesting per acre?	$7.50 per acre	$3	$15	$24	$16 per acre.
44. Per ton of roots?				$3	$1.
45. Distance of crop from station, wharf, or factory?	3 miles	3 miles	8 miles	3½ miles	2½ miles.
46. Cost of delivering?	$4 per acre	65 cents per ton	$2 per ton	$1 per ton	50 cents per ton.
47. Price received per ton of beets?	$5	$5	$6	$5	$5.
48. Are beets preserved in trenches?					
49. How long?					
50. Cost of preparing trenches?					
51. Pulp, how obtained?					
52. Price of pulp at the factory?					
53. Cost delivered on farm?					
54. Estimated feeding value as compared with hay or corn fodder?					
55. Mode of preserving?					
56. Cost of same?					
57. Mode of feeding?					
58. To what animals fed?					
59. Quantity per day per head?					
60. What percentage of sugar in your beets?					
61. What is their average size and yield per acre?			5 pounds; yield, 22 tons		
62. Place of beets in your rotation of crops?					
63. Cost of culture per acre:					
a. Of beets?	$110.90	$53	$113.40	$84.40	$73.
b. Of corn?					
c. Of potatoes?					
64. Value of crops per acre:					
a. Of beets?	$80	$30	$132	$40	$80.
b. Of corn?					
c. Of potatoes?					
65. Average yield per acre:					
a. Of beets; tons?	16 tons	6 tons	22 tons	8 tons	16 tons.
b. Of corn; bushels?					
c. Of potatoes; bushels?					

CONDITION OF SUGAR-BEET CULTURE IN MAINE—Continued.

Number of entry	156	157	158	159	160
1. Kind of seed sown?	French pink beet	Sugar beet	German sugar beet	German sugar beet	Sugar beet.
2. Source of same?	Maine Beet Sugar Co		Maine Beet Sugar Co	Maine Beet Sugar Co	Maine Beet Sugar Co.
3. Quantity sown per acre?	10 pounds per acre	14 pounds	10 pounds	14 pounds per acre	14 pounds per acre.
3a. Cost of same?	$2	$2.80	$2	$2.80	$2.80.
4. Location of field, upland or lowland?	Upland	Upland	Upland	Upland	Upland.
5. Is your soil sand, limestone, clay, slate, or loam?	Loam	Loam	Rocky loam	Clay loam	Loam.
6. Is it well drained?	Yes	Yes	Yes	Yes	Yes.
7. Is the drainage natural or artificial?	Natural	Natural	Natural	Natural	Natural.
8. Area planted in sugar beets?	½ acre	1 acre	½ acre	½ acre	½ acre.
9. Crop on same land previous year?	Sweet corn	Corn	Cabbage	Corn	Hay.
10. Time of first plowing?	November, 1878	Last of April	Fall	Fall	November.
11. Depth of same?	9 inches	1 foot	7 or 8 inches	8 inches	6 inches.
12. Cost of same per acre?	$3 per acre	$4		$3 per acre	$4.
13. Time of second plowing?	May 1, 1879	May 10	Spring		
14. Depth of same?	10 inches	6 inches	7 or 8 inches		
15. Cost of same?	$4 per acre	$5			
16. Was subsoil plowing employed?	No	No		No	No.
17. Depth of same?					
18. Note other operations of preparation of the soil, and cost of same.	Harrowing; $2 per day	$3			Harrowing; $1.25.
19. Planting, date?	May 10				May 20 to 25.
20. Method of—by hand or drill?	By hand	Drill	Hand	Norton's	By hand.
21. Cost of planting?	$4 per acre	$1.50		$3	$6 per acre.
22. Distance between the rows?	2 feet	2 feet	28 inches	2 feet	20 inches.
23. Distance between the roots?	6 to 8 inches	8 inches	8 inches	4 to 6 inches	8 inches.
24. Was stable manure applied to the crops?	Yes	Yes; 4 cords	Yes; 4 cords per ½ acre	Yes	No.
25. When, and in what quantity per acre?	5 cords per acre; $15	$12	$12		
26. Was artificial manure applied?	Yes	No	Yes; at planting		Superphosphate.
27. When; how; what; how much; cost?	500 pounds; $15		400 pounds; $12		$10.
28. Time of first hoeing?	May 30	June 1			June 1.
29. Done by hand or horse cultivator?	Both	Hand			Hand.
30. If special implement used, describe it					
31. Cost of first hoeing?	$7	$32			$6 per acre.
32. Area hoed by each laborer per day?	$\frac{1}{16}$ acre	$\frac{1}{32}$ acre			½ acre.
33. Wages of laborers, by day or month?	$1 per day	$1 per day			$1 per day.
34. Time and cost of second hoeing?	June 16; $4	$6			5 days; $5.
35. Date and cost of third hoeing?	July 24; $3.50				August 1; $2.
36. Date and cost of thinning?	June 21; $4				
37. How was thinning done; by hand, hoe, or special implement for the purpose?	By hand	Hand and hoe	Hoe and hand	Garden fork	By hand.
38. Time of harvesting?	October 16	October 1	October 20	October 15	November 1.
39. Mode of pulling, by hand or with instrument?	Fork	Hand	Hand		By hand.
40. Surface pulled by each man per day?	⅛ acre	⅛ acre			

41. Mode of removing leaves or tops; by hand or with knife?	Knife	Hand and knife	Knife	Knife	Knife.
42. Quantity topped by each laborer per day?	3½ tons				
43. Total cost of harvesting per acre?	$15	$6		$20 per acre	$9.
44. Per ton of roots?	70 cents per ton	5 tons		12 tons per acre	
45. Distance of crop from station, wharf, or factory?	3 miles	30 miles	⅓ mile	2½ miles	1 mile.
46. Cost of delivering?		80 cents per ton		$1 per ton	
47. Price received per ton of beets?	$5	$6	$5	$5	$5.
48. Are beets preserved in trenches?	Yes	No			No.
49. How long?	Can't say				
50. Cost of preparing trenches?					
51. Pulp, how obtained?					
52. Price of pulp at the factory?					
53. Cost delivered on farm?	$2.25 per ton				
54. Estimated feeding value as compared with hay or corn fodder?					
55. Mode of preserving?					
56. Cost of same?					
57. Mode of feeding?					
58. To what animals fed?					
59. Quantity per day per head?					
60. What percentage of sugar in your beets?					
61. What is their average size and yield per acre?	1 pound; 10 tons				
62. Place of beets in your rotation of crops?					
63. Cost of culture per acre:					
a. Of beets?	$78.50	$76.30			$46.05.
b. Of corn?					
c. Of potatoes?					
64. Value of crops per acre:					
a. Of beets?	$50	$30	$65	$60	$25.
b. Of corn?					
c. Of potatoes?					
65. Average yield per acre?					
a. Of beets; tons?	10 tons	5 tons	13 tons	12 tons	5 tons.
b. Of corn; bushels?					
c. Of potatoes; bushels?					

CONDITION OF SUGAR-BEET CULTURE IN MAINE—Continued.

Number of entry	161	162	163	164	165
1. Kind of seed sown?	White sugar beet		White imperial	Imported sugar beet	German seed.
2. Source of same?	Maine Beet Sugar Co	Germany	Maine Beet Sugar Co	Maine Beet Sugar Co	Maine Beet Sugar Co.
3. Quantity sown per acre?	12 pounds	12 pounds	12 pounds	14 pounds	12 pounds.
3a. Cost of same?	$2.40	$2.40	$2.40	$2.80	$2.40.
4. Location of field, upland or lowland?	Lowland	Upland	Upland	Lowland	Upland.
5. Is your soil sand, limestone, clay, slate, or loam?	Sandy loam	Sand and clay loam	Loam and sandy	Clay loam	Sandy loam.
6. Is it well drained?	Yes	Yes	No	Yes	Yes.
7. Is the drainage natural or artificial?	Natural	Natural	Natural	Artificial	Natural.
8. Area planted in sugar beets?	48 rods	¼ acre	1 acre	1 acre	½ acre.
9. Crop on same land previous year?	Potatoes	Corn	Potatoes	Marsh grass	Indian corn.
10. Time of first plowing?	October, 1877	April 25	October, 1878	November, 1878	Fall, 1878.
11. Depth of same?	6 inches	14 inches	8 inches	12 inches	6 inches.
12. Cost of same per acre?	$4	$9.37	$4	$8	$4.
13. Time of second plowing?	October, 1878	May 5	May 12, 1879		May 15, 1879.
14. Depth of same?	6 inches	12 inches	9 inches		7 inches.
15. Cost of same?	$4	$6	$4		$4 per acre.
16. Was subsoil plowing employed?			No	No	No.
17. Depth of same?					
18. Note other operations of preparation of the soil, and cost of same.	Harrowing, &c.; $2.50 per acre.		Harrowed; $3	Harrowing; $1	Harrowing, $1.
19. Planting, date?	Middle of May	May 10	May 23	May 30	May 23.
20. Method of—by hand or drill?	Drill	By hand	By hand	Drill	By hand.
21. Cost of planting?	$4	$6	$6	$5	$4.50.
22. Distance between the rows?	2½ feet	28 inches	3 feet	30 inches	3 feet, on account of grass.
23. Distance between the roots?	6 inches	8 inches.	5 inches	8 inches	4 to 10 inches.
24. Was stable manure applied to the crops?	Yes; $24	Yes; at planting	Yes	Yes; 4 cords	Yes; 4½ cords.
25. When, and in what quantity per acre?	8 cords	28 cords (?)	6 cords; $24	$12	$22.
26. Was artificial manure applied?	Yes		No	Yes; superphosphate	Yes; lobster.
27. When; how; what; how much; cost?	$16			400 pounds; $8	$7.50.
28. Time of first hoeing?	Middle of June	June 3	June 1	June 20	June 19.
29. Done by hand or horse cultivator?	Hand-hoeing	Horse-cultivator	Both	Both	Horse-cultivator.
30. If special implement used, describe it?					
31. Cost of first hoeing?	$12	$4	$2	$3	
32. Area hoed by each laborer per day?	½ acre	¼ acre	½ acre	¼ acre	
33. Wages of laborers, by day or month?	$1 per day	$1		75 cents per day	
34. Time and cost of second hoeing?	July 1; cost $12	June 20; $5	June 20; $2	June 30; $3	June 28: $2.50
35. Date and cost of third hoeing?		July 12; $6	July 10; $2		June 20; $2.
36. Date and cost of thinning?		June 8; $8	June 10; $5		July 15; $3.
37. How was thinning done; by hand, hoe, or special implement for the purpose?	Hand	By hand	By hand	By hand	By hand.
38. Time of harvesting?	Last of October	October 10	October 20	October 23	October 27.
39. Mode of pulling, by hand or with instrument?	Hand	By hand	By hand	By hand	By hand.
40. Surface pulled by each man per day?	¼ acre	⅓ acre	¼ acre	¼ acre	⅓ acre.

41. Mode of removing leaves or tops; by hand or with knife?	Knife	Knife	Knife	With knife	Knife.
42. Quantity topped by each laborer per day?	From 3 to 4 tons	½ acre	3 tons	1 ton	3 tons.
43. Total cost of harvesting per acre?	$10	$7	$6.25	$11	$10.
44. Per ton of roots?	50 cents		66 cents	$1	$1.25.
45. Distance of crop from station, wharf, or factory?	3 miles to depot	¾ mile	¼ mile to station	2½ miles	1½ miles.
46. Cost of delivering?	$1.25 per ton	80 cents per ton	$8.25 per acre	$6 per acre	50 cents per ton.
47. Price received per ton of beets?	$5	$6	$5	$5	$5.
48. Are beets preserved in trenches?					
49. How long?					
50. Cost of preparing trenches?					
51. Pulp, how obtained?					
52. Price of pulp at the factory?					
53. Cost delivered on farm?					
54. Estimated feeding value as compared with hay or corn fodder?					
55. Mode of preserving?					
56. Cost of same?					
57. Mode of feeding?					
58. To what animals fed?					
59. Quantity per day per head?					
60. What percentage of sugar in your beets?					
61. What is their average size and yield per acre?	3 pounds; yield 18 to 19 tons.		1 pound; yield 9 tons	10¾ tons	3 to 6 inches; 16 tons.
62. Place of beets in your rotation of crops?					
63. Cost of culture per acre:					
a. Of beets?	$114.65	$63.37*	$68.90	$59.80	$70.90.
b. Of corn?					
c. Of potatoes?					
64. Value of crops per acre:					
a. Of beets?	$95	$72	$45	$53.75	$80.
b. Of corn?					
c. Of potatoes?					
65. Average yield per acre:					
a. Of beets; tons?	19 tons	12 tons	9 tons	10¾ tons	16 tons.
b. Of corn; bushels?					
c. Of potatoes; bushels?					

* Stable manure not included.

CONDITION OF SUGAR-BEET CULTURE IN MAINE—Continued.

Number of entry	166	167	168	169	170
1. Kind of seed sown?	French sugar beet	Sugar beet	Sugar beet	White sugar beet	
2. Source of same?	Maine Beet Sugar Co	Maine Beet Sugar Co	Germany	Maine Beet Sugar Co	Maine Beet Sugar Co.
3. Quantity sown per acre?	5 pounds	14 pounds	14 pounds	14 pounds	14 pounds.
3a. Cost of same?	$1	$2.80	$2.80	$2.80	$2.80.
4. Location of field, upland or lowland?	Upland	Lowland	Intermediate	Dry upland	Upland.
5. Is your soil sand, limestone, clay, slate, or loam?	Sandy loam	Sandy	Sandy loom	Limestone	Sandy loam.
6. Is it well drained?	Yes	Yes	No	Yes	Yes.
7. Is the drainage natural or artificial?	Natural	Natural	Natural	Natural	Natural.
8. Area planted in sugar beets?	1 acre	1 acre	½ acre	¾ of an acre	1 acre.
9. Crop on same land previous year?	Corn and cabbage	Corn	Corn	Corn and beans	Potatoes.
10. Time of first plowing?	November 1, 1877	November, 1878	May 1	Fall	Fall of 1878.
11. Depth of same?	8 to 10 inches	8 inches	8 inches	5 inches	8 inches.
12. Cost of same per acre?	$6	$3	$4	$2 per acre	$3.
13. Time of second plowing?	April 20, 1879	May 10	May 20	Spring	Last of May.
14. Depth of same?	1 foot	10 inches	8 inches	5 to 6 inches	8 inches.
15. Cost of same?	$4	$4.	$4	$2	$3.
16. Was subsoil plowing employed?	No	Yes	No	No	No.
17. Depth of same?		2 inches			
18. Note other operations of preparation of the soil, and cost of same.		Harrowing; $2	Harrowing; $1	Harrowing; $3	Harrowing, &c.; $6.
19. Planting, date?	April 25	May 15	Last of May		May 10.
20. Method of—by hand or drill?	Both	Hand	By hand	By hand	
21. Cost of planting?	$4 per acre	$4	$5	$4 per acre	$3.
22. Distance between the rows?	3 feet	18 inches	30 inches	2 feet	30 inches.
23. Distance between the roots?	8 inches	8 inches	8 inches	6 to 10 inches	8 inches.
24. Was stable manure applied to the crops?	Yes; 8 cords	Yes; 16 cords	Yes; 20 cords	Yes; 6 cords	Yes; 8 cords.
25. When, and in what quantity per acre?	$32	$48	At planting; $60	$18	$24.
26. Was artificial manure applied?	No	Yes; superphosphate	No	Yes; Stockbridge	Yes; 200 pounds.
27. When; how; what; how much; cost?		600 pounds; $22.50		$10	Stockbridge; $5.
28. Time of first hoeing?	May 15 to 20	June 1	Middle of June		June 20.
29. Done by hand or horse cultivator?	By hand	Hand	By hand	Hand	Hand.
30. If special implement used, describe it					
31. Cost of first hoeing?	$3	$9	$2	$4 per acre	$3.
32. Area hoed by each laborer per day?		18 square rods	¼ acre	¼ acre	
33. Wages of laborers, by day or month?		$1 per day	$1 per day		
34. Time and cost of second hoeing?	$5	June 15; $7	August; $2	$6	$3.
35. Date and cost of third hoeing?	June 25; $10	June 28; $7	June; $4	$4	
36. Date and cost of thinning?		June 15; $3			$3.
37. How was thinning done; by hand, hoe, or special implement for the purpose?	Both	Both	Both	Hand	Both.
38. Time of harvesting?	October 15	October 28	November	October	October.
39. Mode of pulling, by hand or with instrument?	By hand	Hand	Hand	By hand	By hand.
40. Surface pulled by each man per day?		¼ of an acre	¼ acre	¼ acre	

41. Mode of removing leaves or tops; by hand or with knife?	Knife	Knife	Knife	Knife	Knife.
42. Quantity topped by each laborer per day?		3 tons	1½ tons		1 ton.
43. Total cost of harvesting per acre?	$11	$10	$8	$9	$10.
44. Per ton of roots?	75 cents	50 cents	$2 per ton	12 tons	
45. Distance of crop from station, wharf, or factory?	2 miles from station	60 rods	3 miles from station	4½ miles	7 miles from factory.
46. Cost of delivering?	50 cents per ton		50 cents per ton	$1 per ton	$1 per ton.
47. Price received per ton of beets?	$5	$5	$5	$5	$6.
48. Are beets preserved in trenches?				Yes	
49. How long?					
50. Cost of preparing trenches?				From factory	
51. Pulp, how obtained?				$1.80 per ton	
52. Price of pulp at the factory?					
53. Cost delivered on farm?					
54. Estimated feeding value as compared with hay or corn fodder?					
55. Mode of preserving?					
56. Cost of same?					
57. Mode of feeding?					
58. To what animals fed?					
59. Quantity per day per head?					
60. What percentage of sugar in your beets?					
61. What is their average size and yield per acre?	Yield 15 tons	20 tons	24 tons	1 to 5 pounds	14 tons.
62. Place of beets in your rotation of crops?					
63. Cost of culture per acre:					
a. Of beets?	$83.50	$122.30	$104.80	$76.80	$79.80.
b. Of corn?					
c. Of potatoes?					
64. Value of crops per acre:					
a. Of beets?	$75	$100	$120	$60	$84.
b. Of corn?					
c. Of potatoes?					
65. Average yield per acre:					
a. Of beets; tons?	15 tons	20 tons	24 tons	12 tons	14 tons.
b. Of corn; bushels?					
c. Of potatoes; bushels?					

CONDITION OF SUGAR-BEET CULTURE IN MAINE—Continued.

Nature of entry	171	172	173	174	175
1. Kind of seed sown?	White sugar beet	White sugar beet	Sugar beet	White sugar beet	Sugar beet.
2. Source of same?	Maine Beet Sugar Co		Imported	Maine Beet Sugar Co	Imported.
3. Quantity sown per acre?		13 pounds	14 pounds	14 pounds	6 pounds ½ acre.
3a. Cost of same?		$2.60	$2.80	$2.80	$2.40.
4. Location of field, upland or lowland?	Upland	Upland	Lowland	Upland	Upland.
5. Is your soil sand, limestone, clay, slate, or loam?	Sand	Clay loam	Loam	Clay loam	Loam.
6. Is it well drained?		No	Yes	Yes	
7. Is the drainage natural or artificial?			Natural	Natural	Natural.
8. Area planted in sugar beets?	¼ acre	1 acre	1 acre	½ acre	¼ acre.
9. Crop on same land previous year?	Beans and beets	Corn	Corn	Grass	
10. Time of first plowing?	Middle of May	November	Middle of May	Fall	April 25.
11. Depth of same?	10 inches	10 inches	8 inches	6 inches	8 inches.
12. Cost of same per acre?	$2.50 per acre	$3			$2.
13. Time of second plowing?		June 1			
14. Depth of same?		7 inches			
15. Cost of same?	$2.50	$3	$2		
16. Was subsoil plowing employed?	No			No	
17. Depth of same?					
18. Note other operations of preparation of the soil, and cost of same.	Harrowing; $1.25 per acre.	Harrowing; $2			Harrowing; $2 per acre.
19. Planting, date?	Last of May	June 15	May 16	June	May 1.
20. Method of—by hand or drill?	Hand	Drill	Drill	Hand	By hand.
21. Cost of planting?	$3 per acre	$7	$3		$2.50.
22. Distance between the rows?	2 feet	2 feet	30 inches	3½ feet	2 feet.
23. Distance between the roots?	6 inches	4 inches	8 inches	6 to 8 inches	8 inches.
24. Was stable manure applied to the crops?	Yes; 4 cords per acre	Yes; 12 cords	Yes; 10 cords	Stable manure	Yes; in furrows.
25. When, and in what quantity per acre?	$20	$36	$30		6 cords; $18.
26. Was artificial manure applied?	No	Yes; hen manure	No	No	
27. When; how; what; how much; cost?		$5			
28. Time of first hoeing?	June 16	June 29	June 1	Last of June	May 25.
29. Done by hand or horse cultivator?	Horse cultivator	Horse cultivator	Both	Hand	By hand.
30. If special implement used, describe it		Hand hoe			
31. Cost of first hoeing?	$1 per acre	$6	$4.50		$2.25.
32. Area hoed by each laborer per day?		⅓ acre	¼ acre		
33. Wages of laborers, by day or month?		$1 per day	$1.25 per day		
34. Time and cost of second hoeing?	$5	August 1; $10	$3		June 10; $2.
35. Date and cost of third hoeing?			July 25; $2		July 15; $2.
36. Date and cost of thinning?	$5				July 20; $1.50.
37. How was thinning done; by hand, hoe, or special implement for the purpose?	Hand	Hand	By hand	Hand	By hand.
38. Time of harvesting?	August 14	October	October 15	Middle of October	October 29.
39. Mode of pulling, by hand or with instrument?	Hand	By hand	Hand	By hand	By hand.
40. Surface pulled by each man per day?	1 acre	⅓ of an acre	¼ acre		½ acre.

41. Mode of removing leaves or tops; by hand or with knife?	Knife	Knife	Knife	Knife	Knife.
42. Quantity topped by each laborer per day?	½ acre	⅛ of an acre			¼ acre.
43. Total cost of harvesting per acre?	$3.75	$15	$5		$6.
44. Per ton of roots?	47 cents	$1.25			
45. Distance of crop from station, wharf, or factory?	¾ of a mile	4 miles	1 mile from depot	1½ miles	5 miles.
46. Cost of delivering?	$1.25 per acre	$1 per ton	50 cents per ton		$1 per ton.
47. Price received per ton of beets?	$5	$6 per ton	$5	$5	$5.
48. Are beets preserved in trenches?					
49. How long?					
50. Cost of preparing trenches?					
51. Pulp, how obtained?					
52. Price of pulp at the factory?					
53. Cost delivered on farm?					
54. Estimated feeding value as compared with hay or corn fodder?					
55. Mode of preserving?					
56. Cost of same?					
57. Mode of feeding?					
58. To what animals fed?					
59. Quantity per day per head?					
60. What percentage of sugar in your beets?					
61. What is their average size and yield per acre?	Medium size	2 pounds; 12 tons	12 tons	20 tons	10 tons.
62. Place of beets in your rotation of crops?					
63. Cost of culture per acre:					
a. Of beets?	$50.25	$101.60	$58.30		$50.65.
b. Of corn?					
c. Of potatoes?					
64. Value of crops per acre:					
a. Of beets?	$40	$72	$60	$100	$50.
b. Of corn?					
c. Of potatoes?					
65. Average yield per acre;					
a. Of beets; tons?	8 tons	12 tons	12 tons	20 tons	10 tons.
b. Of corn; bushels?					
c. Of potatoes; bushels?					

CONDITION OF SUGAR-BEET CULTURE IN MAINE—Continued.

Number of entry	176	177	178	179	180
1. Kind of seed sown?	Sugar beet	Sugar beets	Sugar beet	White beet	
2. Source of same?	Maine Beet Sugar Co.		Germany	Portland Company	Beet Sugar Company.
3. Quantity sown per acre?	10 pounds	14 pounds per acre	12 pounds per acre	14 pounds per acre	14 pounds.
3a. Cost of same?	$2	$2.80	$2.40	$2.40	$2.40.
4. Location of field, upland or lowland?	Upland mostly	Interval	Upland	Lowland	Lowland.
5. Is your soil sand, limestone, clay, slate, or loam?	Rocky loam	Sandy	Sandy loam	Dark loam	Sandy.
6. Is it well drained?	Yes	Yes	Yes	Yes	Yes.
7. Is the drainage natural or artificial?	Natural	Natural	Natural	Natural	Natural.
8. Area planted in sugar beets?	1 acre	½ acre	⅝ acre	1 acre	½ acre.
9. Crop on same land previous year?	Turnips		Corn	Corn	Corn.
10. Time of first plowing?	May 25	April 29	May 5	May 16	Fall, 1878.
11. Depth of same?	9 inches	8 inches	10 inches	9 inches	5 inches.
12. Cost of same per acre?	About $2.50	$4	$9 per acre	$1.25	$2.
13. Time of second plowing?					May 15.
14. Depth of same?				6 to 8 inches	6 inches.
15. Cost of same?				45 cents	$2.
16. Was subsoil plowing employed?		No		No	No.
17. Depth of same?					
18. Note other operations of preparation of the soil, and cost of same.	Harrowing; $1.50	Harrowing, &c., $2		45 cents	Harrowing; 25 cents.
19. Planting, date?	May 29	May 5	May 12	May 23	May 17.
20. Method of—by hand or drill?	Drill	Hand	Drill	Drill	Hand.
21. Cost of planting?	$1	$1	$3 per acre	$1.40	$3.
22. Distance between the rows?	24 inches	2 feet	30 inches	2 feet	18 inches.
23. Distance between the roots?	6 to 8 inches	1 foot	7 to 8 inches	8 to 10 feet	6 inches.
24. Was stable manure applied to the crops?	Yes; 8 cords	Yes; 6 cords per acre	Yes	No	Yes; 12 cords.
25. When, and in what quantity per acre?	$24	$18			Yes; $60.
26. Was artificial manure applied?	Yes; superphosphate	Yes; superphosphate	No	Yes; Stockbridge	Stockbridge.
27. When; how; what; how much; cost?	600 pounds; $15	$5 per ½ acre	$3 per acre	$20	$10.
28. Time of first hoeing?	June 15	May 28	Last of May	June 17	June 10.
29. Done by hand or horse cultivator?	Horse cultivator	Hand	By hand	Hand; $1	Hand.
30. If special implement used, describe it					$3.
31. Cost of first hoeing?	$2.25	$2	$3 per acre	68 cents	
32. Area hoed by each laborer per day?		¼ acre			
33. Wages of laborers, by day or month?		$1 per day			
34. Time and cost of second hoeing?	July 1; $2.25	June 20; $1.50	$3 per acre	$1.05	June 25; $3.
35. Date and cost of third hoeing?		August; $1		$2.13	July 15; $2.50.
36. Date and cost of thinning?	July 20; $12	June; $3	$7		June 20; $5.
37. How was thinning done; by hand, hoe, or special implement for the purpose?	By hand	Hand	By hand	Hand	Hand.
38. Time of harvesting?	October 20	October	October 15	October 16	
39. Mode of pulling, by hand or with instrument?	By hand	Hand	Hand	By hand	Knife.
40. Surface pulled by each man per day?		½ acre			

41. Mode of removing leaves or tops; by hand or with knife?	Knife	Knife	Knife		
42. Quantity topped by each laborer per day?		2 tons			
43. Total cost of harvesting per acre?	$5		$18 per acre	$13	
44. Per ton of roots?				11⅓ tons	
45. Distance of crop from station, wharf, or factory?	2 miles from station	4½ miles	½ mile from station	5 miles to station	2½ miles to station.
46. Cost of delivering?	$2.50 per acre	$2 per ton*	$3 per acre	92 cents per ton	$1 per ton.
47. Price received per ton of beets?	$4 per ton	$5	$4	$5 per ton	$5.
48. Are beets preserved in trenches?		Yes			
49. How long?					
50. Cost of preparing trenches?					
51. Pulp, how obtained?					
52. Price of pulp at the factory?					
53. Cost delivered on farm?					
54. Estimated feeding value as compared with hay or corn fodder?					
55. Mode of preserving?					
56. Cost of same?					
57. Mode of feeding?					
58. To what animals fed?					
59. Quantity per day per head?					
60. What percentage of sugar in your beets?					
61. What is their average size and yield per acre?	3 tons	20 tons	24 tons per acre	2 to 6 inches in diameter.	30 tons.
62. Place of beets in your rotation of crops?					Second.
63. Cost of culture per acre:					
a. Of beets?	$70	$85.30	$51.40 per acre	$55.25	$123.15.
b. Of corn?					
c. Of potatoes?					
64. Value of crops per acre:					
a. Of beets?	$12	$100	$96	$60	$150.
b. Of corn?					
c. Of potatoes?					
65. Average yield per acre:					
a. Of beets; tons?				12 tons	30 tons.
b Of corn; bushels?					
c. Of potatoes; bushels?					

*Including harvesting. (?)

CONDITION OF SUGAR-BEET CULTURE IN MAINE—Continued.

Number of entry	181	182	183	184	185
1. Kind of seed sown?		German sugar beet	German sugar beet	Sugar beet	Sugar beet.
2. Source of same?	Maine Beet Sugar Co	Portland	Portland	Maine Beet Sugar Co	Maine Beet Sugar Co.
3. Quantity sown per acre?	14 pounds	4½ pounds per acre	6 pounds ½ acre	7 pounds	14 pounds per acre.
3a. Cost of same?	$2.80	$90	$2.20	$1.40	$2.80.
4. Location of field, upland or lowland?	Upland	Upland	Upland	Upland	Upland.
5. Is your soil sand, limestone, clay, slate, or loam?	Sandy loam	Clay loam	Loam	Clay loam	Sandy loam.
6. Is it well drained?	Partly		Yes		Yes.
7. Is the drainage natural or artificial?	Natural	Natural	Artificial	Natural	Natural.
8. Area planted in sugar beets?	¾ of acre	½ acre	½ acre	½ acre	¼ acre.
9. Crop on same land previous year?	Corn		Potatoes	Wild land	Corn.
10. Time of first plowing?	Fall	May 15	August, 1877	October, 1878	May 7.
11. Depth of same?	8 inches	7 inches	8 inches	12 inches	6 inches.
12. Cost of same per acre?	$5	$4 per acre	$3	$8 per acre	$2.50 per acre.
13. Time of second plowing?	Spring		May 1, 1879	May 10, 1879	May 20.
14. Depth of same?	9 inches		9 inches	12 inches	6 inches.
15. Cost of same?	$2		$1.50	$5	$1.50 per acre.
16. Was subsoil plowing employed?	No		No	No	No.
17. Depth of same?					
18. Note other operations of preparation of the soil, and cost of same.	$2	$1 per ½ acre	Harrowing; $1	Harrowing, &c.; $10	Harrowing; $1.50.
19. Planting, date?	May 29	May 28	May 9, 1879	May 16	May 28.
20. Method of—by hand or drill?	Hand	Hand	Hand	Hand	Seed-sower.
21. Cost of planting?	$5	$2	$1	$2	$1.25 per acre.
22. Distance between the rows?	30 inches	3 feet	3 feet	24 inches	3½ feet.
23. Distance between the roots?	4 to 10 inches	4 inches	8 inches	6 inches	10 inches.
24. Was stable manure applied to the crops?	Yes	Yes; barn-yard	Yes	Yes; 8 cords per acre	Yes; May 1.
25. When, and in what quantity per acre?	15 cords per acre	8 cords per acre. $24	2 cords; in May	May 14; $40	10 cents per acre; $30.
26. Was artificial manure applied?	Yes; Cumberland	Yes	$4	Yes; 400 pounds; $9	No.
27. When; how; what; how much; cost?	800 pounds; $18		Yes; $3	Bradley's superphosphate.	
28. Time of first hoeing?	June 12	June 25	June 1	June 6 (?)	June 12.
29. Done by hand or horse cultivator?	Hand	By hand	Horse		Horse.
30. If special implement used, describe it					
31. Cost of first hoeing?	$3.75	$4	About 40 cents	$12 per acre	$1.50 per acre.
32. Area hoed by each laborer per day?			½ acre	⅛ acre	¾ of an acre.
33. Wages of laborers, by day or month?	$15 by season			$1.50	$1 per day.
34. Time and cost of second hoeing?	June 30; $8	July; $4	June; $3	$12 per acre	July 1; $5 per acre.
35. Date and cost of third hoeing?	June 30; $4		August; $1	July 8 to 20; $12 per acre	July 20; $5 per acre.
36. Date and cost of thinning?	June 19	July 6; $1.50		July 10; $8	July 20; $1 per acre.
37. How was thinning done; by hand, hoe, or special implement for the purpose?	Hand	Hand	Hand	Hand	Hand.
38. Time of harvesting?	October 20	October 15	October 15	October 30	October 25.
39. Mode of pulling, by hand or with instrument?	Hand	Hand	Hand	Hand	By hand.

40. Surface pulled by each man per day?	¼ acre	1 man ½ acre per day	¼ acre	1 acre	1 acre.
41. Mode of removing leaves or tops; by hand or with knife?	Knife	Knife	Knife	Knife	Knife.
42. Quantity topped by each laborer per day?		1 man ¼ acre per day		⅛ acre	1 acre.
43. Total cost of harvesting per acre?	$28	$7 per acre	$4	$13 per acre	$3.
44. Per ton of roots?	$2.54				
45. Distance of crop from station, wharf, or factory?	3½ miles to station	5 miles to station	3 miles	70 miles (to factory) (?)	
46. Cost of delivering?	$1.50 per ton	$1 per ton	$4 per acre	40 cents per ton	
47. Price received per ton of beets?	$5	$5	$5	$6	$3.50.
48. Are beets preserved in trenches?	No		No		
49. How long?					
50. Cost of preparing trenches?					
51. Pulp, how obtained?					
52. Price of pulp at the factory?				$1	
53. Cost delivered on farm?					
54. Estimated feeding value as compared with hay or corn fodder?					
55. Mode of preserving?					
56. Cost of same?					
57. Mode of feeding?					
58. To what animals fed?					
59. Quantity per day per head?					
60. What percentage of sugar in your beets?					
61. What is their average size and yield per acre?	14⅔ tons		8 tons	8 tons	10 tons.
62. Place of beets in your rotation of crops?					
63. Cost of culture per acre:					
a. Of beets?	$100.55*	$54.40	$27.10	$125.10	$59.05.
b. Of corn?					$40.
c. Of potatoes?					$45.
64. Value of crops per acre:					
a. Of beets	$71.66⅔	$25	$40	$48	$35.
b. Of corn?					$68.
c. Of potatoes					$50.
65. Average yield per acre:					
a. Of beets; tons?	14⅔ tons	5 tons	8 tons	8 tons	10 tons.
b. Of corn; bushels?					80 bushels.
c. Of potatoes; bushels?					125 bushels.

*Stable manure not included.

CONDITION OF SUGAR-BEET CULTURE IN MAINE—Continued.

Number of entry	186	187	188	189	190
1. Kind of seed sown?		German		German	Sugar beet.
2. Source of same?	Maine Beet Sugar Co	Maine Beet Sugar Co	Maine Beet Sugar Co	Maine Beet Sugar Co	Maine Beet Sugar Co.
3. Quantity sown per acre?	14 pounds per acre	8 pounds	8 pomds	About 10 pounds	About 4 pounds.
3a. Cost of same?	$2.80	$1.60	$1.60	$2	80 cents.
4. Location of field, upland or lowland?	Upland	Upland	Lowland	Rather low land	Upland.
5. Is your soil sand, limestone, clay, slate, or loam?	Gravelly loam	Loam	Sand	Clay loam	Clay loam.
6. Is it well drained	Yes	No	Yes	No	Yes.
7. Is the drainage natural or artificial?	Natural		Natural	Natural	Natural.
8. Area planted in sugar beets?	½ acre	½ acre	¼ acre	¼ acre	½ acre.
9. Crop on same land previous year?	Corn	Hay	Corn	Grass	Hay.
10. Time of first plowing?	May 1	April 4	May 15, 1878	August, 1878	November, 1878.
11. Depth of same?	8 inches	6 to 7 inches	8 inches	8 inches	8 inches.
12. Cost of same per acre?	$3	$4	$4 per acre	$3.25	$4.
13. Time of second plowing?			May 10, 1879	May, 1879	Fall.
14. Depth of same?			9 inches	6 inches	
15. Cost of same?			$2 per acre	$2.25	$4 per acre.
16. Was subsoil plowing employed?	No	No	No	No	No.
17. Depth of same?					
18. Note other operations of preparation of the soil, and cost of same.	Harrowing, &c., $1.50	Harrowing, &c.; $2.50	Harrowing, &c.; $2 per acre.	Harrowing; $2 per acre.	Harrowed and furrowed.
19. Planting, date?	May 4	May	May 12	June 11	May 22.
20. Method of—by hand or drill?	By hand	Hand	By hand	Drill	By hand.
21. Cost of planting?	$2.50	$5	$4 per acre	About $1 per acre	$2.
22. Distance between the rows?	18 inches	2½ feet	From 20 to 24 inches	2½ feet	32 inches.
23. Distance between the roots?	4 inches	6 to 8 inches	4 to 8 inches	8 inches	2 to 10 inches.
24. Was stable manure applied to the crops?	Yes; before plowing	Yes	Yes	Yes	
25. When, and in what quantity per acre?	6 cords per acre; $12	8 cords; $24	4 cords per acre; $16	Before plowing	
26. Was artificial manure applied?	No		Yes; 400 lbs. per acre	Yes; Stockbridge	
27. When; how; what; how much; cost?			$10	$5 per acre	$4 per acre.
28. Time of first hoeing?	June 1	June	June 15	July 1	
29. Done by hand or horse cultivator?	Horse cultivator	By hand	Both	Both	By hand.
30. If special implement used, describe it?					
31. Cost of first hoeing?	$2.50	$3	$5 per acre	$14 per acre	$1.
32. Area hoed by each laborer per day?		¼ acre	¼ acre		⅛ of an acre.
33. Wages of laborers, by day or month?			$1.25	$1 per day	$1 per day.
34. Time and cost of second hoeing?	June 19; $1.50	June 15; $2.50	July 1; $1	August 1; $6 per acre	$4.
35. Date and cost of third hoeing?	June 20; $2	June 31; $2			$2.
36. Date and cost of thinning?		$2			$4.
37. How was thinning done; by hand, hoe, or special implement for the purpose?	Hand	Both	Both	Both	Hand.
38. Time of harvesting?	November 1	Middle of October	October 20	October 16	November.
39. Mode of pulling, by hand or with instrument?	Hand	Hand	Hand	Hand	Hand.
40. Surface pulled by each man per day?		½ acre	¼ acre	$\frac{1}{10}$ acre	½ acre.

41. Mode of removing leaves or tops, by hand or with knife?	Knife	Knife	Knife	Knife	Knife.
42. Quantity topped by each laborer per day?		½ acre	2 tons		½ acre.
43. Total cost of harvesting per acre?	$8.50		$12 per acre	$10 per acre	$10 per acre.
44. Per ton of roots?	50 cents		75 cents		$1 per ton.
45. Distance of crop from station, wharf, or factory?	3 miles	4 miles	1½ miles	2 miles	4½ miles.
46. Cost of delivering?	75 cents per ton	$1 per ton	50 cents per ton	$1 per ton	80 cents per ton.
47. Price received per ton of beets?	$5	$5	$5	$5.	$5.
48. Are beets preserved in trenches?					
49. How long?					
50. Cost of preparing trenches?			By cars		
51. Pulp, how obtained?				From factory	
52. Price of pulp at the factory?			$2	$1 per ton	
53. Cost delivered on farm?			$4	$1.80 at depot	
54. Estimated feeding value as compared with hay or corn fodder?					
55. Mode of preserving?					
56. Cost of same?					
57. Mode of feeding?					
58. To what animals fed?			Cows		
59. Quantity per day per head?			16 quarts		
60. What percentage of sugar in your beets?					
61. What is their average size and yield per acre?	17 tons	Size 4 lbs.; 12 tons	Size 4 lbs.; 17 tons	20 tons	10 tons.
62. Place of beets in your rotation of crops?					
63. Cost of culture per acre:					
a. Of beets?	$49.05	$58.60	$66.10	$44.50	$43.80.
b. Of corn?	$28				
c. Of potatoes?	$30				
64. Value of crops per acre:					
a. Of beets?	$85	$60	$85	$100	$60.
b. Of corn?	$32.50				
c. Of potatoes?	$57.50				
65. Average yield per acre:					
a. Of beets; tons?	17 tons	12 tons	17 tons	20 tons	10 tons.
b. Of corn; bushels?	50 bushels				
c. Of potatoes; bushels?	115 bushels				

CONDITION OF SUGAR-BEET CULTURE IN NEW HAMPSHIRE.

Number of entry	1	2	3	4	5
1. Kind of seed sown?	Sugar beet	Silesian seed		German sugar beet	
2. Source of same?	Maine Beet Sugar Co	Maine Beet Sugar Co	Maine Beet Sugar Co	Maine Beet Sugar Co	Maine Beet Sugar Co.
3. Quantity sown per acre?	10 pounds per acre	10 pounds	12 pounds	14 pounds	10 pounds.
3a. Cost of same?	$2	$2	$2.40	$2.80	$2.
4. Location of field, upland or lowland?	Level upland	Lowland	Upland	Upland	Upland.
5. Is your soil sand, limestone, clay, slate, or loam?	Sandy loam	Clay loam	Loam	Sandy loam	Clay loam.
6. Is it well drained?	Yes	Partly	Yes	Yes	
7. Is the drainage natural or artificial?	Natural		Natural	Natural	Natural.
8. Area planted in sugar beets?	1 acre	2 acres	½ acre	½ acre	
9. Crop on same land previous year?	Potatoes	Potatoes and corn	Corn	Corn	Beets and turnips.
10. Time of first plowing?	May 9, 1879	May 20, 1879		April 25	May 1.
11. Depth of same?	10 miles	9 and 10 inches	9 inches	12 miles	14 inches.
12. Cost of same per acre?	$6	$5	$3	$3	$2.
13. Time of second plowing?		None			May 10.
14. Depth of same?			7 inches		14 inches.
15. Cost of same?			$2		$1.50.
16. Was subsoil plowing employed?	Double Mich. plow	No	No	No	
17. Depth of same?	10 inches				
18. Note other operations of preparation of the soil, and cost of same.	Harrowing; $3	Harrowing, &c.; $4 per acre.		Harrowed; $1	Harrowing; $2.
19. Planting, date?	May 10	June 1, 1879	May 10	May 12	May 12.
20. Method of—by hand or drill?	Seed sower, in drills	Seed sower; by drill	Hand	Drill	Drill.
21. Cost of planting?	$1	$1 per acre	$5 per acre	$1	$2.50.
22. Distance between the rows	30 inches	2½ feet	30 inches	30 inches	12 inches.
23. Distance between the roots?	8 inches	2½ feet	6 inches	8 inches	8 to 10 inches.
24. Was stable manure applied to the crops?		Yes	Yes	Yes	Yes.
25. When, and in what quantity per acre?		6 cords per acre; $24	8 cords per acre; $32	10 cords per acre; $50	5 cords; $20.
26. Was artificial manure applied?	Yes; Stockbridge	Applying manure; $8	Yes; Bradley's phosphate.	Yes; Stockbridge	Yes.
27. When; how; what; how much; cost?	800 pounds; $20		$5.30 per acre	800 pounds per acre; $20	800 pounds; $20.
28. Time of first hoeing?	May 26	June 25, 1879		June 2	June 1.
29. Done by hand or horse cultivator?	Hand	Both	Both	Horse	Both.
30. If special implement used, describe it?				Light two-winged plow	
31. Cost of first hoeing?	$3	$8	$6 per acre	$4	
32. Area hoed by each laborer per day?	⅓ acre	⅛ per acre	⅛ per acre	⅛ acre	
33. Wages of laborers, by day or month?	$1 per day	$1 per day	$17 per month	$1 per day	75 cents per day.
34. Time and cost of second hoeing?	June 13; $16	July 15; $6	$6 per acre	June 18; $2	$2.50.
35. Date and cost of third hoeing?	July 12; $7	August 5; $5	$6 per acre	July 7; $1	$2.25.
36. Date and cost of thinning?				June 10; $2	$3.
37. How was thinning done; by hand, hoe, or special implement for the purpose?	Both	Both	Hand and hoe	Hand	
38. Time of harvesting?	Middle of October	October 25	Last of October	October 21	October 22.
39. Mode of pulling, by hand or with instrument?	Hand	Hand	Hand and plow	Hand	

40. Surface pulled by each man per day?	⅛ acre	⅛ of an acre		⅛ acre	½ acre.
41. Mode of removing leaves or tops; by hand or with knife?	Knife	Hand and knife	Both	Knife	Knife.
42. Quantity topped by each laborer per day?	10 rods	⅛ of an acre		1 ton	½ acre.
43. Total cost of harvesting per acre?	$13	$8	$16	$18	$18.
44. Per ton of roots?	$1.25	50 cents		$1	
45. Distance of crop from station, wharf, or factory?	¼ mile from railroad	1 mile from railroad	1 mile	1 mile to station	½ mile.
46. Cost of delivering?	80 cents per ton	80 cents per ton	50 cents per ton	50 cents per ton	
47. Price received per ton of beets?	$5	$5	$5	$5	$5.
48. Are beets preserved in trenches?	Yes				
49. How long?					
50. Cost of preparing trenches?					
51. Pulp, how obtained?				By car from Portland	
52. Price of pulp at the factory?				$1	
53. Cost delivered on farm?				$2.50	
54. Estimated feeding value as compared with hay or corn fodder?					
55. Mode of preserving?				Kept from air	
56. Cost of same?					
57. Mode of feeding?				Mixed with meal	
58. To what animals fed?				Cows	
59. Quantity per day per head?				1 bushel	
60. What percentage of sugar in your beets?					18 tons.
61. What is their average size and yield per acre?	10 tons	16 tons; weight, 2½ pounds.	20 tons	4 pounds; yield, 18 tons.	
62. Place of beets in your rotation of crops?					
63. Cost of culture per acre:					
a. Of beets?	$79	$83.80	$93.70	$113.80	$76.75.
b. Of corn?		$64.40		$59	
c. Of potatoes?		$72		$61	
64. Value of crops per acre:					
a. Of beets?	$50	$80	$100	$90	$90.
b. Of corn?		$45			
c. Of potatoes?		$75			
65. Average yield per acre:					
a. Of beets; tons?	10 tons	16 tons	20 tons	18 tons	18 tons.
b. Of corn; bushels?		60 bushels			
c. Of potatoes; bushels?		150 bushels			

Number of entry	1	2	3	4	5
1. Kind of seed sown?		Sugar beet		German sugar beet	White Silesian.
2. Source of same?	Maine Beet Sugar Co	Germany	Maine Beet Sugar Co	Maine Beet Sugar Co	Maine Beet Sugar Co.
3. Quantity sown per acre?	14 pounds	11 pounds	20 pounds	9 pounds	4 pounds. (?)
3a. Cost of same?	$2.80	$2.20	$4	$1.80	80 cents.
4. Location of field, upland or lowland?	Medium	Upland	Upland	Upland	Upland.
5. Is your soil sand, limestone, clay, slate, or loam?	Loam		Sandy loam	Clay loam	Loam.
6. Is it well drained?	Fair	Yes	No	Tolerably	Yes.
7. Is the drainage natural or artificial?	Natural	Natural	Natural	Natural	Natural slope.
8. Area planted in sugar beets?	1 acre exactly	2 acres	1 acre	Nearly 3 acres	¼ acre.
9. Crop on same land previous year?	Early potatoes	Cabbages and potatoes		Corn	Corn.
10. Time of first plowing?	May 17	April 1	May 9	October	May 10, 1878.
11. Depth of same?	9 inches	9 inches	12 inches	8 inches	7 inches.
12. Cost of same per acre?	$4	$1.25	$3	$3	$4.
13. Time of second plowing?		May 4	May 26	April	May 22.
14. Depth of same?		9 inches	7 inches	9 inches	12 inches.
15. Cost of same?		$1.25	$2	$3	$5.
16. Was subsoil plowing employed?	No	No	No	No	
17. Depth of same?					
18. Note other operations of preparation of the soil, and cost of same.	Harrowing, &c.; $6			Harrowing, &c.; $2	Harrowing, &c.; $2.
19. Planting, date?	May 22	May 15	May 11	May	May 23.
20. Method of—by hand or drill?	Sargent Monitor	Drill	Drill	Drill	Sargent's seed sower.
21. Cost of planting?	$2		75 cents	$1	$2.
22. Distance between the rows?	20 inches	17 inches	22 inches	17 inches	3 feet.
23. Distance between the roots?	10 to 12 inches		6 to 8 inches	6 to 10 inches	8 inches.
24. Was stable manure applied to the crops?	Yes	Yes	Yes	Yes; 10 cords	Yes; 8 cords per acre.
25. When, and in what quantity per acre?	8 cords; $40			$50	$72.
26. Was artificial manure applied?	No	Yes; Stockbridge	Yes; Stockbridge	Yes; Stockbridge	Yes; phosphate.
27. When; how; what; how much; cost?		$15	$10	$5	500 pounds; $12.50.
28. Time of last hoeing?	June 11	June 10	June 24	May	June 16.
29. Done by hand or horse cultivator?	Hand and hoe	Hand		By hand	Horse.
30. If special implement used, describe it.					
31. Cost of first hoeing?	$3		$8	$2.50	$3.
32. Area hoed by each laborer per day?			⅛ acre	½ acre	½ acre.
33. Wages of laborers, by day or month?	$1.50 per day	$1 per day		$1.25	$1.50 per day.
34. Time and cost of second hoeing?			July 28; $6	May; $2.50	June 30; $3.
35. Date and cost of third hoeing?				June; $5	August 1; $1.
36. Date and cost of thinning?	$3		July 21; $8	June; $5	
37. How was thinning done; by hand, hoe, or special implement for the purpose?	June 19; $18	Hand	By hand	Hand	Hand.
38. Time of harvesting?	October 28	October 30	October 15	October 10	October 20.
39. Mode of pulling, by hand or with instrument?		Plowed out	Hand	Hand	By hand.
40. Surface pulled by each man per day?	⅛ acre		⅓ acre		¼ acre.

41. Mode of removing leaves or tops; by hand or with knife?	Knife	Knife	Knife	Knife	Knife.
42. Quantity topped by each laborer per day?	⅛ acre				2 tons.
43. Total cost of harvesting per acre?	$20		$10	$15	$12.50.
44. Per ton of roots?	67 cents		50 cents	75 cents	$1.
45. Distance of crop from station, wharf, or factory?	1½ mile from depot	½ mile	1 mile	½ mile to railroad	4 miles from railroad.
46. Cost of delivering?	75 cents per ton		$4 per acre	25 cents per ton	$1.50 per ton.
47. Price received per ton of beets?	$5	$5	$5	$5	$5.
48. Are beets preserved in trenches?			No	No	
49. How long?					
50. Cost of preparing trenches?					
51. Pulp, how obtained?					
52. Price of pulp at the factory?					
53. Cost delivered on farm?					
54. Estimated feeding value as compared with hay or corn fodder?					
55. Mode of preserving?					
56. Cost of same?					
57. Mode of feeding?					
58. To what animals fed?					
59. Quantity per day per head?					
60. What percentage of sugar in your beets?	26 tons	12 tons	1½ to 2 pounds	3 or 4 pounds; 20 tons	4 pounds; 15 tons.
61. What is their average size and yield per acre?					
62. Place of beets in your rotation of crops?					
63. Cost of culture per acre:					
a. Of beets?	$118.30		$55.75	$101.30	$125.30.
b. Of corn?					$100.
c. Of potatoes?					$115.
64. Value of crops per acre:					
a. Of beets?	$130	$60	$100	$100	$75.
b. Of corn?					$45.
c. Of potatoes?					$165.
65. Average yield per acre:					
a. Of beets; tons?	26 tons	12 tons	20 tons	20 tons	15 tons.
b. Of corn; bushels?					
c. Of potatoes; bushels?					

TABLE B.

RESUMÉ OF CONDITIONS OF CULTURE OF THE SUGAR BEET IN NEW ENGLAND AND THE RESULTS OBTAINED IN 1879.

MAINE.

Number of entry.	Pounds of seed sown.	Character of soil.	Depth of plowing.			Previous crop.	Separation of roots.	Quantity of stable manure.	Artificial manure.	Time of planting.	Time of first hoeing.	Yield per acre.	Value of crop at $5 per ton.	Estimated cost of crop.	Remarks.
			First time.		Second time.										
			Fall.	Spring.											
			Inch.	*Inch.*	*Inch.*		*Inches.*	*Cords*	*Lbs.*			*Tons.*			
1	12	Sandy	------	8	10–11	Wheat	24 by 8	7	500	May 12 to 16	June 1	16	$80 00	$70 25	
2	14	Sandy loam	------	8	------	Corn	30 by 8	5	500	May 10	....do	14	70 00	45 20	
3	14	....do	------	8	2	Beets, carrots	24 by 6	20	------	May 5	May 15	15	75 00	180 30	
4	14	Loam	------	9	------	Corn, beans	25 by 6	------	------	May 15		3	15 00	17 05	Only plowed once.
5	14	....do	------	12	------	Potatoes	24 by 8	10	------	May 30	June 3	3	------	------	
6	11	....do	------	15	------	Corn	30 by 10	10	800	May 10 to 15	June 1	14	70 00	124 20	
7	12	Sand, clay	------	11	8		24 by 6	17	------		Last of June	------	------	------	
8	10	Loam	8	------	12	Potatoes	22 by 8	8	500	May 12	June 1	6	30 00	77 75	
9	14	Clay, sand	------	12	------	....do	24 by 12	6	------	May 15	June 20	------	------	6 80	1 foot from center.
10	14	Gravelly	------	10	12	....do	20 by 10	20	200	May 5	June 1	20	100 00	62 30	
11	14	Clay loam	------	8	6	Corn	25 by 8	5	------	May 25 to June 10	June 20, July 1	14	70 00	84 30	
12	8	Clay	------	7	8	....do	24 by 12	16	250	May 20	Last of June	14	70 00	116 85	Too thick.
13	10	Gravelly loam	------	5	------	....do	24 by 8	3	------	May 25		10	60 00	47 50	At $6 per ton.
14	12	Clay loam	------	6	------	Oats	24 by 8	4	800		July 2	12	60 00	67 90	
15	------	Red loam	------	7	7	Grass	24 by 8	5	200	May 15	June 20	12	60 00	77 50	4 barrels wood-ashes.
16	6	Sandy loam	------	14	14	Corn, beets	18 by 8	8	800	June 1		12	60 00	119 95	
17	6–7	....do	------	6	------	Potatoes, corn	15 by 8	8	------	May 10	May 25	20	30 00	64 15	
18	10–12	Clay loam	------	8	------	Grass	24 by 10	7	400	May 15		8	40 00	61 90	
19	12	Black loam	------	6	------	Barley, oats	22 by 8	8	800	May 10	June 20	12	60 00	79 40	
20	10	Sand loam	------	12	4	Sweet corn, potatoes.	24 by 8	7–8	------	May 12	June 1	16	80 00	128 00	
21	14	Clay soil	------	10	------	Potatoes	36 by 8	6	------	May 6	June 2	18	90 00	56 50	
22	14	Loam	8	------	8	....do	24 by 8	6	------	May 20		10	90 00	43 30	
23	------	Clay loam	------	12–15	------	Oats	26 by 8	6	300		June 9	13	50 00	71 80	
24	10–12	....do	------	------	------	Beans, potatoes	18 by 12	10	------	May 10 to 20	June 1	18	65 00	63 00	
25	10	Sandy loam	------	8	10–11	Corn	24 by 8	5	------	May 7		15	108 00	------	At $6 per ton.
26	12	Sand, clay	------	9	10	Potatoes	24 by 8	------	200	May 10 to 15	June 10	4	20 00	54 40	
27	10	Clay loam	8	------	------	Corn, beans	40 by 8	10	------			10	50 00	------	
28	10	Sand, clay	------	10	------	Potatoes, grass	30 by 8	------	------	Last of May	July 1	10	50 00	------	
29	10	Loam	------	12	------	Beets	22 by 10	10	------	May 25	June 10	20	120 00	90 50	At $6 per ton.
30	14	....do	------	9	9	Corn, potatoes	18 by 8	5	800	....do	June 15	32	192 00	118 80	
31	6	Sand	6	------	10	Corn	40 by 8	------	50	June 10	July 1	------	------	------	

32	8	Loam		8	Turnips	24 by 10			May 20	June 1	16	80 00	54 60		
33	2⅔	Clay loam	7		Beans	24 by 6	15	400	May 10	May 25	7½	37 50	67 50		
34	14	Loam		13	Corn	20 by 8	20		May 12	June 16	5	25 00	70 80		
35	10	....do		10	6	....do	24 by 8	12		May 19	June 18	11	55 00	76 50	Plowed but once.
36	10	....do		8	4	Potatoes	24 by 8	6	400	May 21	June 9	17	85 00	82 50	
37	5⅓	Light loam		12		Corn	18 by 8	4			June 20				
38	7½	Clay loam	6			Hay	24 by 6	8	100	Last of May	....do	14	70 00	70 00	
39	10	Gravelly loam		8						May 20	....do	12	60 00		Plowed but once.
40	14	Clay loam		10		Potatoes	24 by 10	12		April 29	May 10	22	110 00	84 80	
41	7	Sandy loam		8						Last of May	Last of June	15	75 00	21 90	New land.
42	12	Heavy loam		12		Sweet corn	40 by 8	8		May 12	May 20				
43		Loam		6		Y. G. beets	20 by 10			May 10	June 1	20	100 00		
44	14	Gravelly loam	8			Sod land	24 by 8	8		May 15	June 5	20	120 00	45 80	At $6 per ton.
45	14	Clay	8			Potatoes		30	5	June 1	Last of June	32	160 00	99 90	Drained by plowing.
46				8											
47	14	Loam		5	5	Beets	30 by 8	10		Middle of June		4	20 00	48 55	
48	8	....do		8			36 by 8	8		May 15		14	70 00	71 60	
49	14	Stone loam		8		Corn	30 by 10	2	300		June 25, July 10	14	70 00	61 68	
50	10	Clay, sand		8		....do	30 by 6		800	May 15	July 1, August 1	15	75 00	98 75	
51	14	Loam	6		8	....do	24 by 8	4	500	May 12	June 12	16	80 00	49 55	
52	14	Clay		8–10	5–6	Beets	24 by 8	6	1,000	May 15	June 15	20	100 00	98 80	
53	7	Clay loam		9	9	Potatoes	20 by 8	10	200	May 24	June 10	15	75 00	68 40	
54	10	....do		8		Oats	16 by 8	4	200	May 15	June 6	20	100 00	45 00	Plowed but once.
55	8	Slaty loam		8–10		Beets, carrots	30 by 8	8	400	May 19	June 1	12	60 00	75 00	
56	10	Gravelly loam		8	8	Sweet corn, turnips	14 by 8	3	200	May 13	May 30	15	75 00	44 50	
57	10	Clay loam		9	9	Potatoes, corn	30 by 10	6	600	May 20 to 30	June 15 to 20	10	50 00	84 20	
58	7	....do		10	6	Corn, potatoes	30 by 8	12		May 10	May 30	18	90 00	142 90	
59	11	Sandy loam		8		Hay	24 by 8	6		May 24		12½	62 50	40 70	Not complete.
60	6	....do		6		Potatoes	24 by 8	20		May 15	June 20	16	80 00	93 60	
61	10–12	Clay loam				Sugar beets	30 by 8	8	300	May 12	June	10–20		29 25	
62	14	....do		7	7	Corn	30 by 8	7		May 12	June 19	20	100 00	116 70	
63	7	....do		8		Potatoes	36 by 6	5	500	May 8 and 9	June 1	15	75 00	69 40	
64	7	Loam		5–6	6	Corn	22 by 8	3½	350	May 10	June 5	14	70 00	59 40	
65	12	....do	12		12	Corn, grass		12	400	May 15	June 5	16	80 00	116 40	
66	13	....do	8		10	Corn	24 by 8	10	600	May 12	June 1	12	60 00	76 60	
67	6	Clay loam	9			Potatoes	30 by 8		800	May 12	July 1	6	30 00	54 70	Under-drained.
68	12	Fine slate loam	6–8			Grass	30 by 6	20	500	March 15	June 10	12¾	63 75	119 15	
69	10	Loam		12	12	Corn	30 by 8	8	260	May 10	June 10	14	70 00	60 80	
70	4	Sandy loam	8		9	....do	24 by 8	5	250	May 1	June 10	10	50 00	60 10	
71	14	Clay loam		10		Potatoes	18 by 8	12	200	May 15		20	100 00	90 05	
72	14	Sandy loam	10		10	Corn	22 by 8	24	200	May 13	Last of May	11	66 00	37 80	
73	14	....do		7		Cucumbers	26 by 8	10		May 17	June 10	16	80 00	70 50	
74	7	....do	9		12	Corn	28 by 8	6		May 7 to 15	June 2	20	100 00	70 40	
75	7	Gravelly loam		6	6–8	....do	30 by 8	10	800	May 24	June 25	16½	82 00	160 02	
76	7	Clay loam		8		do	24 by 6		600	May 30	June 25	6	30 00	44 65	Planted too late.
77	14	....do		8	8	Potatoes	24 by 8	9		May 25	June 15	10	50 00	56 80	
78	14	Sand, gravel		12–14	12–14	Hops, corn	24 by 8	4	200	May 30	June 10	10	50 00	74 80	
79	10	Clay subsoil		10		Corn	30 by 10	4	800	May 26		12	60 00	78 00	
80	15	Sand and loam		8			28 by 6	13	*150	May 18	June 19	15	90 00	109 50	$6 per ton.
81	12	Slate		10		Corn	36 by 10	10	450	June 1	June 15 or 20	18	108 00	105 40	Do.
82	14	Clay loam		8		Cabbage	18 by 8	8	100	May 13	June 10	16	96 00	70 30	Do.

* Bushels of ashes.

RÉSUMÉ OF CONDITIONS OF CULTURE OF THE SUGAR-BEET IN NEW ENGLAND, &c.—Continued.

MAINE—Continued.

Number of entry.	Pounds of seeds sown.	Character of soil.	Depth of plowing.			Previous crop.	Separation of roots.	Quantity of stable manure.	Artificial manure.	Time of planting.	Time of first hoeing.	Yield per acre.	Value of crop at $5 per ton.	Estimated cost of crop.	Remarks.
			First time.		Second time.										
			Fall.	Spring.											
			Inch.	*Inch.*	*Inch.*		*Inches.*	*Cords*	*Lbs.*			*Tons.*			
83	10	Sand and clay	.....	10	.....	Corn	20 by 8	4	50	May 15	June 6	30	$80 00	.....	
84	6	Clay loam	8	.....	6 or 7	Barley	24 by —	10	.....	May 20	.....	16	80 00	$90 20	
85	8	Loam	6	.....	7	Potatoes	24 by 8	8	800	May 20	July 19	19	95 00	91 60	
86	12	Sand loam	.....	9	.....	Beets	20 by 8	4	400	May 10	June 1	17	85 00	54 90	
87	10	Limestone	.....	8	.....	Potatoes	36 by 8	8	.....	May 25	June 10	10	50 00	60 50	
88	7	Sandy loam	.....	8	.....	Cabbage	24 by 10	.....	375	June 1	July 3	16	80 00	.....	
89	12	Loam	8	.....	9	Corn	36 by 8	16	560	May 19	June 30	14	70 00	59 00	
90	28	Black loam	6	.....	10	Potatoes	24 by 5	10	800	May 25	June 15	14	70 00	64 10	
91	14	Loam	.....	6–8	.....	Corn	36 by 6	8	.....	May 25	June 15	16	80 00	80 55	
92	14	do	.....	10	.....	.....	24 by 8	.....	800	May 20	July 5	4	20 00	47 80	
93	10	Clay and sand	8	.....	6	Beets, sweet corn	24 by 8	.....	800	May 1 to 15	.....	10	50 00	33 25	
94	5	Loam	.....	8–10	.....	.....	30 by 8	10	.....	May 17 and 24	June 17	14	70 00	73 50	
95	6	Rocky loam	.....	10	10	Corn	18 by 6	7	.....	June 1	June 15	18	90 00	79 20	
96	7	Lime and clay	.....	8	.....	Corn, potatoes	30 by 10	6	.....	May 25	June 10	12	60 00	71 40	
97	10	Clay loam	.....	10	.....	Beets	30 by 6	.....	200	May 20	.....	12	60 00	.....	
98	.....	Loam	.....	10	.....	Potatoes	20 by 24	10	.....	May 20	June 20	10	50 00	.....	
99	8	Dry, gravelly	.....	5	.....	Beans	36 by 8	4	.....	May 1	.....	9	45 00	53 10	
100	6	Gravelly	6	.....	8	.....	24 by 6	6	350	May 26	June 15	12	60 00	110 50	
101	10	Loam	.....	8	.....	.....	15 by 8	7	.....	May 15	June 1	12	60 00	58 50	
102	14	Clay	.....	7	7	.....	30 by 8	20	200	May 21	June 14	39	195 00	.....	
103	10	Red loam	6	.....	10–12	Corn	18 by —	8	1,000	May 15	June 1	20	100 00	122 00	
104	10	Sand and clay	.....	8–10	.....	Potatoes, carrots	30 by 8	15	.....	May 20	June	23¾	118 75	114 12	
105	7	Partly clay	8	.....	8	Corn	24 by 6	.....	.....	May 1	Last of May	20	100 00	41 70	
106	7	Loam	8	.....	10	Corn, beans	24 by 6	12	.....	May 15	June 24	17	85 00	170 65	
107	12	Sandy loam	.....	8	.....	Corn, potatoes	18 by 6	5	400	Early in May	.....	10	50 00	.....	
108	14	Loam	.....	11	10	Corn	30 by 8	8	.....	May 12	June 10	12	72 00	73 80	$6 per ton.
109	8	High land	.....	16	.....	Sweet corn	26 by 10	8	.....	May 15	June 1	13	65 00	79 60	
110	14	Loam	10	.....	10	Potatoes	30 by 8	6	800	May 17	June 24	12	60 00	83 80	
111	14	Clay loam	10	.....	10	Corn	24 by 6	8	.....	May 10 to 25	June 15	17	102 00	115 55	Ground bone, ashes, and plaster, $6 per ton.
112	12	.....	.....	9	.....	Potatoes	26 by 8	10	500	May 10	June 1	15	75 00	77 40	
113	6	Clay loam	7	.....	9	Corn, beans	24 by 6	6	.....	May 13	June 15	13	65 00	75 20	

114	7	Black loam	9–10		9–10	Corn	20 by 8	5		May 15	June 5	16	80 00	67 50	
115	12	Clay loam	8		6	do	20 by 8	7		May 20	June 16	15	75 00	53 40	
116	6	Sandy loam		12		Grass	27 by 8	12		May 23	June 10	16	80 00	63 20	
117	9	do		10	10		24 by 10	15		May 20	June 15	16	80 00		
118	10	Black loam		8			20 by 6	6		May 3	May 25	12	60 00	52 00	
119	10	Slate	8		8	Beets, corn	24 by 8			May 15, '79	June 1	13½	67 50	55 12	
120	3	Sand and black loam.	8–10			Beets, potatoes	33 by 8	8	400	May 30	June 25	20	100 00	57 50	
121	7	Sand and rock	7–8			Potatoes	30 by 8	6	400	May 7	June 1	4	20 00	55 90	
122	10	Sandy loam	7		10	Corn	36 by 8	6	375	May 10	do	14	70 00	74 53	
123	8	Slate	6		6	Potatoes	22 by 8	6	800	do	do	16	80 00	78 60	
124	8	Sand loam		6		Corn, potatoes	36 by 8	18	500	May 1		18	90 00	94 60	
125	14	do		10		Potatoes	24 by 8	6		May 20	June 27	8	48 00	34 80	$6 per ton.
126	8	do	8		8	Corn	20 by 8	4	200	May 15		16	80 00	43 10	
127	14	Loam		10		Corn, beets	30 by 8	4	200	May 20	June 30	15	75 00	47 80	
128	14	Stiff clay	6		6	Potatoes	12 by 8	2	200	do		15	75 00	61 80	Swamp land.
129	8	Loam		10	10		24 by 14	10		May 10	June 1	10	50 00	47 00	
130		do		8		Corn	36 by 8		200		June 1	10	50 00	29 00	
131	14	do		8–10		Potatoes	20 by 10	8	100	May 12	June 1	12½	62 50	65 30	
132	8	Clay loam	6		6	Corn	24 by 6	10		May 24		12	60 00	83 10	
133	14	Loam	10		10	Potatoes	18 by 8		400	May 16	June 20	13	65 00	68 30	
134	14	do		7		Onions	26 by 6	4	400	June 1	June 15	8	40 00	65 30	
135	13	do		8		Indian corn	30 by 7	12	400	May 18	June 1	20	100 00	73 40	
136		Black loam		8		Corn	30 by 10			May 31	June 19	8	40 00		
137	14	Loam		4–5		do	18 by 8	7		June 2	July 15	12	60 00	58 80	
138	10	do		5		Potatoes	36 by 6	6	250	May 22	June 21	12	60 00	58 50	
139	8	do		10		Potatoes, grass	30 by 10	10		May 24	Last of June	20	100 00	113 10	
140	14	do		8		Corn	30 by 8	6		May —	June 15	16	80 00	87 80	
141	11	Clay loam		12	8	Potatoes	18 by 6	20		May 31	June 30	9	45 00	82 20	
142	10	Slightly clay		8		Hay	36 by 8	9	800	May 27	June 15	4	20 00	58 20	
143	14	Loam		7	7	Corn	32 by 10	8	200	May 17	June 25	15	75 00	74 80	
144	7	Gravelly	8		10	Corn, potatoes	24 by 8	6	800	May 15		13	65 00	70 65	
145	12	Sandy loam		8	8	do	30 by 8	6		May 25	Last of June	16	80 00	74 65	
146	14	Loam		7	8	Corn	24 by 8		800	May 15	May 28	12	60 00	69 30	
147	14	do		9		do	24 by 8	8		May 10	June 1	15	75 00	103 80	
148	12	Sandy loam		10	10	Potatoes	20 by 8	12	600	May 5	do	15	75 00	86 40	Interval on river.
149	14	Black loam		9	6	Beets, potatoes	36 by 8	6				6	30 00	86 30	
150	8	Clay loam		10				9	450	May 12	June 10	10	60 00	96 60	Rolling land; $6 per ton.
151	12	Sand loam		7	8	Corn	24 by 7	14			June 16	16	80 00	110 90	
152	4	Gravelly		7	7	do	28 by 8	8	400	Middle of May		6	30 00	53 00	
153	12	Red loam		10		do	18 by 4	10		May 10	June 16	22	132 00	113 40	
154	12	Sandy loam		7		do	11 by 8	5		May 14	June 10	8	40 00	84 40	
155	10	Slate	7		8	Cabbage	24 by 8	6	500	May 8	May 30	16	80 00	73 00	
156	10	Loam	9		10	Sweet corn	24 by 8	5	500	May 10	May 30	10	50 00	78 50	
157	14	do		12	6	Corn	24 by 8	4			June —	5	30 00	76 30	$6 per ton.
158	10	Rocky loam	8		10	Cabbage	28 by 8	8	400			13	65 00		Not complete
159	14	Clay loam	8		10	Corn	24 by 6					12	60 00		
160	14	Loam	6			Hay	20 by 8		400			5	25 00	46 05	
161	12	Sandy loam	6		6	Potatoes	30 by 6	8	400	May 15 or 16	June 15 or 16	19	95 00	114 65	
162	12	Sand and clay		14	12	Corn	28 by 8	28		May 10	June 3	12	72 00	63 37	$6 per ton.
163	12	Loam, sandy	8		9	Potatoes	36 by 5	6		May 23	June 1	9	45 00	68 90	

RÉSUMÉ OF CONDITIONS OF CULTURE OF THE SUGAR-BEET IN NEW ENGLAND, &c.—Continued.

MAINE—Continued.

Number of entry.	Pounds of seed sown.	Character of soil.	Depth of plowing.			Previous crop.	Separation of roots.	Quantity of stable manure.	Artificial manure.	Time of planting.	Time of first hoeing.	Yield per acre.	Value of crop at $5 per ton.	Estimated cost of crop.	Remarks.
			First time.		Second time.										
			Fall.	Spring.											
			Inch.	*Inch.*	*Inch.*		*Inches.*	*Cords*	*Lbs.*			*Tons.*			
164	14	Clay loam	12	.....	.....	Marsh grass	30 by 8	4	400	May 30	June 20	10¾	$53 75	$59 80	3 feet on account of grass.
165	12	Sandy loam	6	.....	7	Indian corn	36 by 10	4¼	.....	May 23	June 19	16	80 00	70 90	
166	5	do	8–10	.....	12	Corn, cabbage	36 by 8	8	.....	April 25	May 15	15	75 00	83 50	
167	14	Sandy	8	.....	10	Corn	18 by 8	16	600	May 15	June 1	20	100 00	122 30	
168	14	Sandy loam	.....	8	8	Corn	30 by 8	20	.....	Last of May	June 15	24	120 00	104 80	
169	14	Limestone	5	.....	5–6	Corn, beans	24 by 10	6	400	.....	.....	12	60 00	76 80	
170	14	Sandy loam	8	.....	8	Potatoes	30 by 8	8	200	May 10	June 20	14	84 00	79 80	$6 per ton.
171	.....	Sand	.....	10	.....	Beans, beets	24 by 6	4	.....	Last of May	June 16	8	40 00	50 25	
172	13	Clay loam	10	.....	7	Corn	24 by 4	12	.....	June 15	June 29	12	72 00	101 60	$6 per ton
173	14	Loam	.....	8	.....	do	30 by 8	10	.....	May 16	June 1	12	60 00	58 30	
174	14	Clay loam	6	.....	.....	Grass	42 by 8	.....	.....	June —	June 30	20	100 00	.....	No estimate given.
175	.....	.....	.....	8	.....	.....	.....	.....	.....	.....	.....	10	50 00	50 65	
176	12	Loam	.....	.....	.....	.....	24 by 8	6	.....	May 1	May 25	3	12 00	70 00	$4 per ton.
177	10	Rocky loam	.....	9	.....	Turnips	24 by 8	8	600	May 29	June 15	20	100 00	85 30	
178	14	Sandy	.....	8	.....	.....	24 by 12	6	400	May 5	May 28	24	96 00	151 40	$4 per ton.
179	12	Sandy loam	.....	10	.....	Corn	24 by 12	.....	.....	May 12	Last of May	12	60 00	55 25	
180	14	Dark loam	.....	9	6–8	do	24 by 10	.....	800	May 23	June 17	30	150 00	123 15	
181	14	Sandy	5	.....	6	do	18 by 6	12	400	May 17	June 10	14⅔	71 66⅔	100 55	
182	14	Sandy loam	8	.....	9	do	30 by 10	15	800	May 29	June 12	5	25 00	44 40	
183	4½	Clay loam	.....	7	.....	.....	36 by 4	8	.....	May 28	June 25	8	40 00	27 10	
184	12	Loam	8	.....	9	Potatoes	38 by 8	2	.....	May 9	June 1	8	48 00	125 10	$6 per ton.
185	7	Clay loam	12	.....	12	Wild land	24 by 6	8	400	May 16	June 6	10	35 00	59 05	$3.50 per ton.
186	14	Sandy loam	.....	6	6	Corn	39 by 10	10	.....	May 28	June 12	17	85 00	49 05	
187	14	Gravelly	.....	8	.....	do	18 by 4	6	.....	May 4	June 1	12	60 00	58 60	
188	4	Loam	.....	6–7	.....	Hay	30 by 8	8	.....	May —	June 1	17	85 00	66 10	
189	8	Sand	.....	8	9	Corn	24 by 8	4	400	May 12	June 15	20	100 00	44 50	
190	10	Clay loam	8	.....	6	Grass	30 by 8	.....	200	June 11	July —	10	60 00	43 00	

NEW HAMPSHIRE.

1	10	Sandy loam		10		Potatoes	30 by 8		800	May 10	May 26	10	$50 00	$79 50
2	10	Clay loam		9–10		Potatoes, corn	30 by 30	6		June 1	June 25	16	80 00	83 80
3	12	Loam		9	7	Corn	30 by 6	8	200	May 10		20	100 00	93 70
4	14	Sandy loam		12		do	30 by 8	10	800	May 12	June 2	18	90 00	113 80
5	10	Clay loam		14	14	Beets, turnips	12 by 10	5	800	May 12	June 1	18	90 00	76 75

MASSACHUSETTS.

1	14	Loam		9		Early potatoes	20 by 12	8		May 22	June 11	26	$130 00	$118 30
2	11	Sand loam		9	9	Cabbage, potatoes	17		600	May 15	June 10	12	60 00	
3	20	Sandy loam		12	7		22 by 8	8	400	May 11	June 24	20	100 00	55 75
4	9	Clay loam	8		9	Corn	17 by 10	10	200	May 1	May —	20	100 00	101 30
5	4	Loam		7	12	do	36 by 8	8	400	May 23	June 16	15	75 00	125 30

The facts given in the above table are well worthy of consideration by those interested in this important subject. It must be remembered that in many cases no careful record was kept by the farmer, and the figures given are taken from memory; but they are important for the determination of the value of the culture in the section for which they are made, and we therefore feel justified in offering the following observations concerning them.

With very few exceptions the character of the soil as regards natural physical condition was, for the crops reported, favorable to a good yield both as to quantity and quality, but there were, as may be seen by reference to the table, but few cases in which it received any preparation by plowing in the previous fall.

It is true that here the prevailing crops in advance of the beets were plowed ones, which reduced the absolute necessity for fall plowing, and even for more than one plowing in spring, and we find that this was all that was given in a large number of cases.

While the depth of plowing was not as great as is generally recommended by European beet-growers, this may have been limited to a considerable extent by the thickness of the stratum of surface soil which long continued root culture would modify for good. Yet we find scarcely any mention of subsoil plowing, so well known to much more than repay the cost of its application, especially in the culture of root crops, that must take their nourishment through the medium of long-tap roots, and should therefore find no obstacle to their development. The chemical character of the soil was in all cases greatly stimulated by the application of natural and artificial manures; but we see by comparison of the figures given in the table, and the results of French practices, showing the requirements of the average crop, that the quantities applied were extravagantly large, and were sufficient in many cases to have an injurious influence upon the crop. It appears that it would be of greater advantage to the grower to apply the stable manure to a previous crop—say corn or potatoes—and follow these crops by beets, with no application of stable manure, and with a limited application of artificial fertilizer consisting of—

Five parts superphosphate of lime.

Two parts nitrate of soda (Chili saltpeter).

One part muriate of potash* (kainit).

Two parts land plaster.

Of this mixture applied in the row at time of planting 300 pounds per acre would be sufficient for the demands of the crop, if it followed corn, otherwise 500 pounds should be applied.

Such a system of manuring would be quite as favorable to the beet crop, as to quantity, as that which appears to have been generally followed, and would be much better for the quality of the crop for sugar extraction. At the same time it would largely reduce the immediate cost of the beet crop and increase to a marked extent the value of the corn or potato crop. The large cost of the culture of the sugar beet in Maine as shown in the last column of the table would thus be reduced in many cases more than one-half, and the probability is strong that if this system be combined with other changes in the system followed last year, that we shall mention further on, the quantity of the crop would be even greater. If, however, it be the desire of the grower to make an application of stable manure, it should be done in the fall, and the manure should in all cases be thoroughly well rotted, and should be well plowed in. The quantity applied should not exceed five or six cords.

Now as to planting and culture. The quantity of seed recommended and offered by the company was 14 pounds per acre, but we find that a large proportion of the growers made use of a much smaller quantity than this; many times less than one half, and while such practice was not always followed by unfortunate results, it may be said that it must be attended with great care on the part of the planter to avoid the existence of bare spots in the field. It is much better to be called upon to remove

* Or of sulphate of potash.

extra plants than to replace wanting ones by transplanting, and while in careful hands no bad results will follow the use of the smaller quantity of seed yet it is more probable that the larger quantity recommended will give in all hands far better results. The distances between the rows and roots adopted may in general be subject to improvement. The most successful culture in Europe has proven that with horse culture the distance between the rows may be with advantage reduced to 18 inches, and in many cases 14 inches has been the distance adopted. The distance between the roots in the rows has also been reduced to about 7 inches.

This increases the number of roots per acre to nearly double that which can be obtained with the separation indicated in the tables here given, and improves the quality of the root for sugar production.

While the weight of each root will be smaller in such cases,* the ultimate quantity of the crop grown has in France been found to be from 50 to 100 per cent. greater than that obtained by wider separation of the roots.

We may therefore confidently assert that if the separation of the roots in the crops of 1879 in Maine had been reduced to 18 by 7 inches, the profit from the crop would have been materially increased.

That the failure of some of the crops must be referred entirely to the conditions of soil and culture, and not to the existing meteorological conditions is shown by the very favorable indications concerning the latter given in the following statement with which we have been favored by the Chief Signal Officer of the United States Army.

Statement showing the mean temperature, relative humidity, amount of precipitation, and number of rainy days for each month of the year 1879 *at Portland, Me., Eastport, Me., Burlington, Vt., and Boston, Mass., as recorded at the stations of observation of the Signal Service, United States Army, at those places.*

[Compiled from the records on file at the Office of the Chief Signal Officer, United States Army, Washington, D. C.]

Months.	Portland, Me.				Eastport, Me.			
	Mean temperature.	Mean humidity.	Amount of precipitation.	Number of rainy days.	Mean temperature.	Mean humidity.	Amount of precipitation.	Number of rainy days.
1879.	*Degrees.*	*Per cent.*	*Inches.*		*Degrees.*	*Per cent.*	*Inches.*	
January	24.2	75.0	2.30	18	19.3	74.9	1.65	16
February	24.9	72.6	3.80	17	21.6	75.7	3.39	14
March	34.0	73.4	4.42	19	29.9	76.5	3.77	21
April	42.6	63.0	3.68	14	37.5	68.6	3.95	15
May	57.7	66.4	.88	11	47.2	76.2	3.18	14
June	61.8	73.8	6.61	16	53.2	77.3	3.42	17
July	68.0	70.3	3.80	16	60.2	76.1	5.57	16
August	63.9	70.2	3.73	9	59.4	77.5	3.66	12
September	59.9	76.3	2.67	8	55.1	81.2	3.42	16
October	55.6	64.2	1.43	10	49.2	69.1	3.28	10
November	38.5	70.7	4.90	17	34.9	75.3	4.52	16
December	29.2	68.0	3.39	19	23.9	76.7	3.67	16

* This would admit of 49,760 roots per acre, or with an average of 1 pound for each root, a yield of about 22 tons.

Statement showing the mean temperature, &c.—Continued.

Months.	Burlington, Vt.				Boston, Mass.			
	Mean temperature.	Mean humidity.	Amount of precipitation.	Number of rainy days.	Mean temperature.	Mean humidity.	Amount of precipitation.	Number of rainy days.
1879.	*Degrees.*	*Per cent.*	*Inches.*		*Degrees.*	*Per cent.*	*Inches.*	
January	16.6	73.1	.78	17	24.5	62.6	2.79	16
February	16.2	72.1	1.11	17	24.5	66.1	4.35	16
March	28.4	69.0	1.45	17	33.8	73.7	3.90	16
April	39.7	57.9	.97	15	42.4	61.1	6.54	16
May	61.1	52.9	.38	8	59.4	61.8	.97	13
June	62.8	68.0	4.52	17	64.2	70.1	6.24	20
July	70.3	63.3	2.71	19	69.9	69.2	3.09	12
August	67.0	69.3	2.39	11	67.7	73.1	6.71	12
September	59.1	66.9	2.82	16	60.8	73.2	1.84	12
October	54.7	64.7	1.36	11	56.6	64.7	.91	8
November	35.0	73.7	3.56	24	39.2	71.5	2.97	17
December	23.6	74.6	2.22	26	32.6	68.3	5.36	20

ROBERT CRAIG,
Lieutenant, A. S. O., and Assistant.

WAR DEPARTMENT, OFFICE OF CHIEF SIGNAL OFFICER,
Washington, D. C., February 2, 1880.

We see here that the meteorological conditions in New England during the past year have been eminently favorable to beet-root culture either as regards temperature, the number of rainy days, or the amount of precipitation or rainfall.

Some complaints have been expressed in the replies to our circulars concerning the effect of dry weather during the latter part of August, but the above table shows that this was not sufficient to produce any marked reduction in the quantity of the crop. And an examination of the records of the averages of meteorological conditions made up from those of a series of years show, that for New England they compare more closely with those of the beet-growing districts of Europe than for any other section of the United States.

So far as the initial conditions of the culture are concerned, therefore, that is, the physical character of the soil and climatic conditions, two great factors upon which success in the work depends, the farmers of New England have little to contend against. The depth of the surface soil may not be as great as that required by the crop, but this will be improved each year that the culture is followed, not only to the advantage of the beet crop but to other crops as well. In fact, here as elsewhere, the improvement of this culture will react to the advantage of all other cultures accompanying it.

We would also call attention to the estimates of cost of the different operations of culture. In the majority of cases the cost of plowing is estimated at over $4 per acre, and in many cases it is even placed at $8 and above. And these are the figures given for the first and second plowing of sandy soil or a sandy loam in the spring following a plowed crop. They therefore appear entirely too high. Good authorities on the subject in New England and in other parts of the United States place the cost of this operation below $3, and this might be considered a high average for all soils; and in many sections this is the average contract price for such work.

Again we find a large number of estimates for cost of planting placed at $4, $5, and $6. Others are placed at from 75 cents to $2 per acre. Is it not more probable that the latter, all things considered, are nearest the actual cost of the work? Mr. Harris, president of the Maine State Board of Agriculture, estimates cost of marking and planting at $1 per acre; and Mr. Hays, of Portsmouth, N. H., places cost of planting at 50 cents per acre. These gentlemen manage extensive farms; they keep close accounts of

expenditures and are therefore in position to judge of this and other items of cost in the culture. If the estimates found in the replies to our circulars, for the cost of other operations involved in the culture are made upon the same basis, in the cases where they are very high, such as $7 to $10 per acre for hoeing, for instance, it is easy to be seen how, even with the heavy applications of manure that have been made, the figures of the estimates given in the last column of our table may frequently be reduced to such an extent as to show a handsome balance of profit to the farmer.

Again, the estimates for the actual value of the stable manure will seem, in very many cases, to be abnormal. It is true that if it be necessary to purchase it from the stables of the town or village, the prices given, $5 and $6 per cord, are what must be paid. But it can scarcely be reasonably asserted that it will cost anything like this figure to produce it on the farm, and even half the amount named might be considered sufficiently high.

With the criticisms we have made upon the methods of culture followed, as indicated in the replies to the questions of our circular, we leave it to the readers of this report to make their own estimates of the cost of the various operations involved, and we venture the assertion that in almost every case in which an estimate is based upon the suggestions we have given and the system of manuring we have recommended, the total cost will fall below the amounts of value of crop of the past year as given in our table; and, where there is any exception to this fact, the cause thereof may generally be traced to some preventable deficiency in the quality of the soil or its preparation, the quantity of seed sown, or the operations of culture.

Another valuable item of profit to be set opposite the account of cost of the various operations of culture is to be found in the favorable condition in which these operations by their thoroughness leave the soil for subsequent crops. It must also be observed that an average crop of sugar beets, say 15 tons per acre, will provide for the grower a quantity of pulp, resulting from the extraction of sugar, equivalent in feeding value to something over one ton of good meadow hay, which is about the quantity of the average hay crop in New England.

It will therefore appear that, notwithstanding the many unfortunate results of the past year's experience as to expense, the prospects for the future are by no means discouraging. At the bottom of Table A we have brought together the figures showing the comparative cost of culture of beets, corn, and potatoes. In some cases the figures for cost of beets are higher than was reported by the grower, because the latter evidently omitted to include the cost of the stable manure applied, and this was added in making up our estimates.* It is a question whether something should not be added to the cost of culture of the other crops also on this account. Yet where we take the figures given, that is for the cost of simple cultural operations, it appears that the same complaint can be advanced against other crops as against the beet crop, for in the large majority of cases the margin for profit is small for all the crops, the principal advantage being in favor of potatoes first and then beets. But it remains to be seen whether in coming years, with improved methods of culture, this order of things will not be subject to change.

There is still another consideration to which we would call the attention of the farmers of Maine on account of the many statements we have received to the effect that they could better afford to feed their roots to cattle than to sell them to the sugar company at $5 per ton. It is a fact proven by an infinite number of analyses that the pulps from the factory are really of almost as great value for feeding as the roots themselves, and the latter can be purchased from the factory at Portland at the comparatively low rate of $1 per ton. How much better, therefore, to make the exchange with a clear profit. For the information of the farmers who have been the authors of the

* Where the farmer footed up the estimates himself, leaving cost of stable manure out of account, his figures were accepted and entered into this column; otherwise, the cost of stable manure was included at a valuation of $3 or $5 per cord, according to the value most frequently given for the locality.

complaints, we have collected below a statement showing the comparative composition of the different products.

	Per cent. dry matter in raw substance.	Percentage composition of dry matter.					
		Nitrogenous matters.	Fatty matters.	Non-nitrogenous extractive matters.	Non-nitrogenous and fatty matters.	Raw cellulose.	Ash.
Sugar beet	17.75	5.52	.56	81.54	82.10	7.54	4.84
Diffusion pulp (fresh)	7.14	8.28	1.12	56.05	57.17	24.02	10.35
Diffusion pulp, pressed	11.92	8.13	1.00	61.42	61.42	19.54	10.91
Pulp from presses	28.23	6.70	1.48	61.11	62.59	19.79	10.86

Concerning the saccharine value of each crop, which would have been of great value for comparison with the yield and the other operations of culture, etc., it was impossible to get complete information. The farmers had no means for its determination, and really little interest in it, and the sugar company made only a limited number of tests. In fact, a greater number than they made would have been impracticable, on account of the manner in which the roots were received at the works. The average value of this year's crop is given in the following statement received from the company:

"You ask for information as to the percentage of sugar in each particular lot of beets raised for this company. No such analysis has been or could be made. We have received beets from 1,500 farmers delivered at 147 railroad stations as well as at our works here in Portland by wagons and vessels. These crops aggregated 9,000 tons. We made, perhaps, 100 polarizations during our working season of 75 days, but not with reference to any special crop or locality. The average yield was 10 per cent. of fillmasse, or to speak more accurately, 9¾ per cent. of füllmasse (masse-cuite). The beets polarized from 9 to 13 per cent. according to size, quality, etc. We distributed two kinds of seed: the German Imperial seed bought from Ferdinand Knauer, of Grobers, Prussia, and the Collet rose or red top, bought of Vilmorin & Co., of Paris, France. The German or white variety was richer in sugar by 1 per cent. than the French or red variety; but the French variety gave somewhat larger crops."

Respectfully submitted,

WM. McMURTRIE.

Hon. Wm. G. Le Duc,
Commissioner of Agriculture.

APPENDIX E.

POINTS FOR CONSIDERATION WITH REGARD TO THE INTRODUCTION OF THE SUGAR-BEET AND THE MANUFACTURE OF BEET-SUGAR IN THE NORTHWEST AS COMPARED WITH THE BEET-SUGAR PRODUCING COUNTRIES OF EUROPE.

By J. D. Fredericksen.

1. *Climate.*—In Europe the northern part of the temperate zone affords the most favorable conditions for the growth of the sugar-beet and the development of a pure juice from which the sugar is easily extracted. The northern part of Germany, Prussian Saxony, Brunswick, and Hanover; Denmark and the southern and middle sections of Sweden; Belgium, Holland, the northern departments of France; Bohemia and a section in the middle of Russia, all produce beets from which sugar can profitably be manufactured. Sections with complete inland climate seem to produce richer sugar-beets than those with coast climate. In northern Germany and certain parts of Russia and Sweden the beet is generally richer in sugar than in France, Belgium, Holland, or Denmark, the latter countries being more exposed to the sea. In England, where the climate is moist and temperate all the year round, the beets grow bulky but poor in sugar, and there the beet-sugar industry has proved a complete failure.

As to Denmark the climate is not so favorable to the development of sugar in the beets as it might be. The spring is rather dry, so that it is hard to get the plants started, and the fall is so wet that there is a danger for the beets to set flesh at the expense of the quality of the juice. For the same reason the harvest is difficult. Still the industry is flourishing, so that the climate may not be called bad.

The following table shows the average temperature and rainfall at Copenhagen, in Denmark, and in Minnesota:

Months.	Minnesota.		Denmark.	
	Temperature.	Rain.	Temperature (82 years).	Rain (44 years).
	Fahr.	*Inches.*	*Fahr.*	*Inches.*
January	15.85	.49	29.84	1.74
February	14.40	1.07	30.92	1.52
March	23.66	2.24	33.80	1.56
April	37.52	.95	42.08	1.46
May	62.24	1.65	51.62	1.49
June	68.70	11.67	59.90	2.12
July	74.72	1.94	63.14	2.30
August	70.54	3.90	62.24	2.48
September	60.95	5.76	56.12	2.18
October	49.36	3.21	47.84	2.17
November	28.72	1.90	38.84	2.04
December	18.81	.72	33.80	1.69
Total	43.62	35.50	45.84	22.75

Comparing these figures, it would suggest itself that the excessive rainfall in Minnesota in June might favor the development of the young beets, but at the same time make it very troublesome to perform the work of harrowing and hoeing to keep the land clean from weeds. The months of August, September, and October also seem rather moist, making it possible that too much inorganic matter may enter the juice at the time when the beets get ripe. Still, when falling in heavy showers at long

intervals, as it probably does in Minnesota, the rain is neither likely to influence the beets nor to bother the harvest in the same way as when coming down gradually at short intervals. More water will evaporate from the soil, and therefore more rain is needed in Minnesota than in Denmark on account of the higher temperature of the former. According to another account the fall of rain in Minnesota is as follows:

Seasons.	Minneapolis.	Duluth.	Breckinridge.	Pembina.	New Ulm.
Winter	3.105	2.160	4.980	2.750	2.260
Spring	7.960	6.480	6.250	2.450	6.300
Summer	16.304	20.850	14.150	7.250	7.020
Fall	5.108	8.060	3.580	6.910	9.280
Annual	32.456	37.556	28.960	19.360	24.860

With such extraordinary differences within the same State it would seem likely that some sections, at least, may be favored with the proper climate for a successful cultivation of the sugar-beet. The temperature of the summer does not seem excessively high, for even far south on the continent of Europe the beet is grown successfully, and just in those of the above sections where the beets are richest in sugar the summer heat is comparatively high.

2. *Soil.*—The proper soil for the sugar-beet is neither too heavy (clayish), nor too light (sand), nor containing too much organic matter. A well cultivated, rich, and deep soil, that would produce a good crop of barley for malt is well adapted for the sugar-beet. New and rich land, that in a crop of cereals would develop the straw at the expense of the seed, would make a bulky crop of beets, but they would be poor in sugar and rich in non-sugar, detrimental to the extraction of the former from the juice. Land of old cultivation, made rich by continued plowing and manuring, is better than newly broken land. Therefore, without knowing from personal experience, one would imagine the soil of Illinois to be better adapted to the sugar-beet than that of Minnesota. The land should be well drained, either by nature or by pipes laid deep in the ground, allowing no water to remain on the surface at any time.

The limits for the physical condition of the soil are, however, very wide, for we have grown rich sugar-beets on comparatively heavy and on comparatively light soil, the former being made porous by deep drainage and intense stirring with steam-plow and cultivator. But, whether heavy or light, only land in a state of high cultivation could produce beets rich in sugar.

3. *Labor.*—One of the worst drawbacks to the successful introduction of the sugar-beet in the Northwest would seem to be the labor question. Even with the advantage of the best implements to stir the land, thin and clean the ridges, and gather the crop, the hand-labor needed to grow sugar-beets is considerable. Wages being about three times as high in the Northwest as in Denmark, this would increase the expenses at a great rate. Supposing one hand to be needed for three acres of land for four months, about 30 days' work would be necessary to cultivate one acre. Supposing one acre to yield 15 tons of beets or 2,400 pounds of sugar (8 per cent.), 30 days' work, at $1.50 a day, would make $45 an acre, or $3 per ton of beets, or 18¾ cents per hundredweight of sugar, while in Denmark, at 50 cents a day, the labor would only amount to one-third of these expenses. And supposing the product could bear such expenses, would it be possible to gather a sufficient number of hands so as to grow 1,500 acres of beets within the limit for the area of one sugar factory? For it is a deplorable fact that, at the present development of the industry, sugar cannot be manufactured from beets on a small scale, but must be produced in large establishments which require the raw material from a large number of acres. And, on account of the bulky quality of the beets, they cannot bear long transportation, and must therefore be grown within a certain comparatively narrow distance from the factory. Again, during the manufacturing season, which only lasts about four or five months, the factory would employ a

number of hands who, after all of the beets have been disposed of, would have to look for employment elsewhere. While at the time between the clearing of the beet land and the harvesting of the beets the regular harvest of the cereals might give employment to the beet hands, would the forests of Minnesota or other industry dispose of the laboring hands during winter and early spring, until the beet field again might need them? Sugar beets should not be attended to only when the other work of the farm is done and there is nothing else to do; but should be worked when they need working. Without independent labor at the proper time, their cultivation always proves a failure. So also should the manufacture of sugar begin when the beets are ripe and contain most sugar, and it should be continued energetically as long as any beets are left, in order to dispose of the whole crop before too much sugar is lost, for every day after the beets are ripe they grow poorer in sugar. Therefore laboring hands must be at disposal at any time when they are wanted, independent of other work that might need them.

In the factory, the high rate of labor in the Northwest would add considerably to the expenses; while in the beet field where, in Denmark, female hands are employed in a great measure, the labor would probably be three times higher in Minnesota than in the old country, the manufacturing-labor expenses would, no doubt, be twice as high in Minnesota as in Denmark. In the latter country the labor expenses in the factory amount to $1.15 per ton of beets or about .72 cent per pound of sugar.

4. *Other expenses.*—Quite different is the case with regard to other expenses than laboring. The cheapness of the land in the Northwest as compared with rich land in the old country will, no doubt, do much towards reducing the expenses of the growing of beets in Minnesota. In Denmark the rent for rich land amounts to $7 to $8 an acre. In Germany as much as $16 per acre is paid yearly for a rentage lasting ten or twenty years. In the Northwest, improved land could probably be had for less than half the rent in Denmark.

In the factory coal plays a prominent part among the expenses other than labor. In Denmark this item amounts to $1.20 per ton of beets or .75 cent per pound of sugar—the price for coal being $6 per ton. This price being reduced to $2 per ton, the expense for fuel would be 40 cents per ton of beets or .25 cent per pound of sugar only.

5. *Duty.*—In the old country the duty paid to the government by the manufacturers makes a heavy reduction of the profit realized by the production. In Germany the duty is laid on the beets, being raised gradually from 1836, when it was only ¼ silver groschen per hundredweight (11 cents per ton) of beets, to the present time, when it amounts to 9 silver groschen per 100 pounds ($4 per ton). This is, in a great measure, the reason why in Germany the manufacture of beet sugar is developed to such admirable perfection as is the case. The more sugar that could be gained from the beets, the less the duty drew on the profit of the manufacturer, for the duty on 1 ton of beets remained the same whether 6 or 10 per cent. of sugar were extracted. All the efforts of the farmer and the manufacturer had the aim to produce much sugar from a certain weight of beets, not to produce much sugar from an acre of land. Therefore the quantitative yield of beets was neglected, while beets were produced which yielded as much as 10 per cent. of sugar.

In Sweden the same system is adopted. In Belgium and partly in Holland the duty is calculated on the basis of the quantity and richness of the juice extracted from the beets. In France and in Denmark the duty is laid on the sugar produced. For this reason it is in these countries the aim of the producer to get the largest yield of sugar from an acre, only provided that it can be profitably extracted. Therefore the yield of beets is larger, but their contents of sugar less than in Germany. In Denmark the duty is equal to that on imported sugar, amounting to 2.16 cents per pound of raw sugar (below No. 18 Dutch standard) or about $3.45 per ton of beets. The duty in this country being about 3.5 cents for average raw sugar, this item would amount to $5.60 per ton of beets in favor of the manufacturer, provided 8 per cent. of raw sugar can be extracted (besides the molasses).

Summing up these items, the following figures are arrived at in favor or in disfavor of the sugar industry in Minnesota, as compared with Denmark, provided 8 per cent. of sugar is realized in both countries:

	Extra expenses in Minnesota.		Savings in Minnesota.	
	Per ton of beets.	Per pound of sugar.	Per ton of beets.	Per pound of sugar.
Labor in field	$2 00	$0 0125	.....	.....
Labor in factory	1 15	72	.....	.....
Rent	.....	.....	$0 23	$0 0014
Fuel	.....	.....	80	50
Duty	.....	.....	5 60	350
	3 15	197	6 63	414

Deducting the extra expenses from the savings, we arrive at the following real savings in favor of Minnesota:

Per ton of beets $3 48
Per pound of sugar 2.17

But the whole calculation depends upon the question, can beets be grown in Minnesota which will yield 8 per cent. of sugar? The most careful study of tables of rainfall and temperature, and of analysis of the soil, cannot decide the question. The only way is to try. Seed of rich sugar beets should be distributed to intelligent farmers throughout the Northwest, accompanied by directions how to grow beets. The farmers who undertake to carefully make the experiments should be requested to return an average sample of the crop, describing the soil in which the beets are grown, and the treatment of it; the fruits which the land bore in previous years; the manure, if any, that was used; the time at which the manure and the seed were sown, and at which the thinning out, the harrowings and hoeings, and the harvest were performed; the yield per acre, &c. The samples should be analyzed, not only for sugar (and especially that kind of sugar which would turn the polarized light to the right, and which would crystallize), but also for organic and inorganic non-sugar. Such a material for one year would already afford valuable suggestions, and, carried on for several years, such experiments would justify a decided opinion about the propriety of the introduction of the industry. To start a large and expensive factory without such foundation would be to run a great risk, and to establish small and cheap factories would always prove a failure.

As to the plan for establishing sugar factories, several systems prevail in Europe. One is the coöperative, very much like the system of cheese factories and creameries in certain sections of this country. The farmers in a section intending to establish a sugar factory form a joint stock company, and are bound to deliver to the factory the beet crop of a certain number of acres for each share in their possession (in Brunswick generally 8 acres for each share of $100).

For the last ten years the sugar factories have become very expensive, being profitable only when very large and when furnished with the latest inventions. Therefore, the farmers could not afford to build their own factories if it were not for large stock companies which undertake to build and furnish factories for the farmers, leaving the greater part of the cost at low interest to be paid off gradually, against mortgage in the buildings. This plan does not work well in a country where the industry is new, and, though it is no doubt best of all, it cannot be introduced until the beet-sugar industry has proved an unquestionable success, and is known to the people as a safe thing to invest in.

Another plan is for a stock company to establish a factory, buying the beets from the farmers, and return the refuse (pulp) to be consumed on the land, so as not to

exhaust the latter. It is, however, not an easy task to induce the farmers at once to grow an area with beets large enough to furnish a factory with sufficient raw material of good quality for a successful starting. It takes time and experience to learn how to grow rich sugar beets; the best way to learn it is to get direct interest in the profit. Therefore such concerns who build factories, intending to buy the beets in a section where the industry is not previously known, are generally forced to grow a large portion of the beets themselves, by establishing some kind of bonanza farms, or by renting suitable land for the purpose, returning it to the farmers after the crop has been gathered. In fact, this is the only way to secure within reasonable time enough of good raw material, until, by and by, the farmers are educated for the task.

In Denmark the beet-sugar industry was introduced in 1873, when it had been ascertained by experiments during several years that sufficiently rich sugar beets could be grown. Two factories were started, one by an old concern that previously commanded the whole sugar refining business of the country, the other by a new stock company prominently made up of landed proprietors. The former company built a large factory in a fertile section occupied by intelligent farmers, who, it was thought, should furnish the beets. The factory was capable of working up 12,500 tons of beets a year. The first year only 2,500 tons of poor beets were received, and the second year proved but little better. Then the managers were convinced of the necessity of adding farming to their business, and bought a farm of 300 acres, to manage which an expert was engaged. Another year more land was added to the farm, and suitable fields were rented for one year and grown with beets by the manufacturers. On these lands rich sugar beets were grown. In the mean time the farmers learned how to grow the beets, and the quantity received at the factory increased yearly, until now sufficient raw material is furnished so as to run the factory profitably. Large amounts of money were lost during the first five years. The business seemed condemned to failure, but the managers succeeded in keeping it going until the balance turned, and now the factory is flourishing.

The other company went at once to work and rented for twenty years three large farms, of 2,000 acres of land in all, every acre of which was in a state of high cultivation and well drained. This land was divided into four fields and sown successively with wheat, beets, barley, and clover; so that every fourth year beets were grown on the same land. Steam-plows and first class machinery were introduced. The factory was built so as to work up 7,500 to 10,000 tons of beets a year. Besides those grown on the 500 acres of the company, more beets were grown by the company on land rented yearly and being returned to the farmers after use, and as many as possible were bought. In this way the company succeeded in gathering 6,000 tons of tolerably rich beets the very first year, sufficient to make a rather successful start. The factory being built at a time when all materials were as expensive as ever; the price of sugar falling about 30 per cent.; hard competition being brought to bear from the sugar refiners; an excessive duty even higher than that on imported sugar* being at once enforced as soon as the manufacture was started; and finally entering the time of universal financial depression, commanding insufficient capital, the company could, however, not carry the work through, and failed in 1876. A new company took the matter in hand, and carrying on the business on the same principle as it was hitherto managed, have succeded in making it pay well.

Having passed through extraordinary difficulties, the beet-sugar industry in Denmark is now successful. But though a handsome profit is realized by the manufacturers, it is nothing compared with the indirect profit which is the result of the improvement of the land where beets have been grown. The influence on the land of the deep and thorough cultivation, and the use of fertilizers, which go hand in hand with the

* The duty at once laid on the manufacture of beet sugar in Denmark was a few years later acknowledged by the government to be higher than that on imported sugar, and was reduced accordingly. In no other country in the world has this industry suffered an immediate imposure of duty, time being everywhere else allowed for the industry to develop and acquire stability.

growth of the sugar beet, of the beet itself by opening and manuring the soil, and of the stable manure which is produced by this system, is simply wonderful. All other crops are increased and their quality improved. On such land as would previously produce only common barley, a highly praised malting grain is now raised, which brings far better price than the old product. Those farmers who at first looked suspiciously on the new industry are now quite enthusiastic in favor of it, and several factories are about to be built this year.

APPENDIX F.

THE PHYSIOLOGICAL FUNCTIONS OF THE NITRATES AND PHOSPHATES IN THE SUGAR-BEET.

The following remarks made by Herr Strohmer, at a late meeting of the Austro-Hungarian Association of Sugar Manufacturers, constitute so succinct a resumé of the present knowledge of the position and value of the phosphates and nitrates of the alkalies in their relation to the physiological functions of the sugar-beet, that we consider it of value to transcribe them here in full:

Among the conditions of the growth of the sugar-beet, nutrition occupies the highest rank. Numerous tests of manures have been made to resolve this question, but in spite of the trouble and care bestowed, it has been impossible to deduce from them a general rule. From these experiments I may cite those made by Gilbert in later days, showing that by the mineral manures alone or with slight doses of nitrogen constant crops may be obtained, and that the mode of action of nitrogenous manures is rather indirect than direct, and consists in rendering the assimilation of other nutritive materials more ready. In general we may say that tests of manures possess a purely local value; for one and the same place this may, however, render great service and be of the greatest importance.

The classical work of Hanaman on the soil of the neighborhood of Lobositz gives proof of this. But the real question can only be determined by cultural experiments, and the true significance of the results deduced by a knowledge of the laws of nutrition. These laws can be defined only by experiments executed in a truly scientific manner and with the aid of chemistry in alliance with physiology. Experiments with manures have heretofore been as numerous as the experiments in vegetation, undertaken in later years, have been few. The special literature of the subject could not have said less of this work.

It is but a few years since Dr. Kohlrausch and myself published a notice upon experiments in nutrition. It followed from them that an augmentation of the content of sugar in the beet does not correspond with an increasing manuring with nitrate of potash, and that with regard to the total sugar produced in the plants no determined relation is attached to increasing doses of nitrate of potash. It is therefore probable that potassium and nitric acid paralyze each other in part in their physiological action in the production of sugar in the beet. The experiments also enable us to recognize that in all probability the content of nitric acid in the dry matter of the beet is augmented by increasing doses of nitrates. We would not positively declare at this time that nitrates interfere with the formation of sugar, because beets which we ourselves have procured, though having a normal appearance, showed only 5 to 10 per cent. of sugar, while the beets of a preceding experiment made at Prilep by Dr. Kohlrausch, had always given 10 to 16 per cent. It might therefore happen that the lower richness was the consequence of local influences. Hanaman has shown in a brilliant work that the less free (*moins dégagée*) situation of a soil has a powerful influence upon the quality of the beet.

In order to clear up this question we made other experiments in 1876 and 1877 with nitrate of soda and phosphate of potash. Beets manured with the first fertilizer were in both years much less rich in sugar than roots manured with the phosphate. On the other hand they showed a higher content of nitric acid and potien with a quotient of purity much lower than the other roots. The principle we expressed as

probably exact, that is to say, the injurious physiological action of nitrogen and of potassium upon the production of sugar in the beet, is therefore confirmed.

Nor would I omit to state that our test beets were of small size, and as the two series of experiments in the two years presented the same results and the same characters, we may accept as exact the principle in question.

The growth of the leaves gave place to a striking phenomenon. The beets manured with nitrate of soda had more powerful leaves, indicating a large afflux of juice; the surface of the leaves was firm and brilliant. The beets manured with phosphate of potash, on the other hand, bore leaves which were weaker, languishing and much more sensible to the direct solar rays and to heat.

According to the observations and results of vegetable physiology, it is a fact that the production of reserve materials is accomplished in the leaves. The phenomenon above mentioned, the rapid yellowing combined with a very prompt change of the leaf, in consequence of which the reserves produced in them are more frequently given up to the roots, was partly attributed to the higher content of sugar in the beets manured with phosphate of potash. The experiments of Deherain have confirmed this opinion, that the sugar is produced in the leaf; from this it follows that the richer beets are those which have the most leaves. Besides, Sostmann has shown that the content of inverted sugar in the juice of the root gradually diminishes, while the stem of the leaves and the juice of the leaves themselves still contain it in important quantities; but the inverted sugar is in all cases an intermediate product of the transformation of the starch of the granules of chlorophyle into sugar.

An interesting observation has been made by Corenwinder: that the saccharine content of the beet increases with the importance of the surface of the leaves. In our studies the difference in the leaves of each series of experiments led us to make weekly measurements of them. We recognized that the beets manured with nitrate of soda showed, with regard to their leaf surface, a decided growth in length, while the other roots, manured with phosphate of potash, showed in their leafy portions a development in breadth. But the surface of the leaves may be compared with that of an ellipse, and as in this surface, the increase of the shorter axis corresponds for the leaf to an increase of breadth. The leaves manured with phosphate should have a greater surface of leaves for the production of sugar. The manure of phosphate acts principally upon the development of the leaves of the beet, and in a manner more favorable to the formation of sugar.

In order to determine what *rôle* potash plays in this effect of phosphate of potash, we last year made other experiments with this salt and with phosphate of soda. These experiments showed that phosphoric acid combined with soda also acted favorably upon the production of sugar, but not in as efficacious a manner as when combined with potash. In the development of the leaves no striking differences were observed. In these later days the question of Chili saltpeter has become (*brulante*) one difficult to treat. Our experiments in nutrition have not been favorable to this fertilizer. The experments of Bodenbender have also given the same conclusions, especially with regard to the purity of the juice. I would also mention an observation of Vilmorin, which has its importance with regard to the prudence which should be observed in the use of Chili saltpeter. Vilmorin found that nitrate of soda injured the germinative faculty of beet seed.

In the general reunion of the German Association of the past year, Professor Maercker supported the use of Chili saltpeter for beets. In the position in which the orator was placed—he spoke especially of the immediate neigborhood of Magdebourg—we could scarcely object to his conclusions. The principles of Maercker cannot be generalized; he has himself elsewhere admitted this. As the experiments in manuring at Eisleben have proven, such a generalization would soon be controverted by practice.

According to the tests in nutrition thus far worked out, and according to the practical experiments made up to this time, *the use of Chili saltpeter as manure for the sugar beet is, at least from the standpoint of the sugar manufacturer, to be prohibited. In some*

special cases the moderate and intelligent use of this salt may, however, seem justifiable because of its constant indirect action in rendering soluble other nutritive materials.

Experiments with special manures should always decide this, because our knowledge of the soil and of the life of plants will not permit us to give a reply to the question in advance.

Laplace once stated, as the end of chemistry, that this science should teach us to know the movements of atoms as astronomy teaches us to recognize the movements of the heavenly bodies. Agricultural chemistry shall have accomplished its task only when it shall teach all the properties of the soil and all the chemical and physiological properties of plants.

APPENDIX G.

METEOROLOGY AND THE GROWTH OF THE BEET.

By Marie Davy.

[Journal d'Agriculture Pratique, 1880, I, 539.]

In ordinary beet-root culture there is no special phase to consider. The plant is pulled before it has accomplished its preparation for blooming. The duration of growth is therefore limited only by temperature. It is within these conditions that we must endeavor to determine what are the climatic influences which modify the yield in weight of roots and of sugar.

With this crop as for the vine, we have but few documents bearing upon it; but we find in the *Annales Agronomiques* of December, 1879, a very important memoir by M. Pagnoul, of Arras, which provides means for a primary examination of this great question, and we must applaud the fruitful efforts of the able directors of the agricultural stations of France in the scientific paths into which they have entered. The preliminary examination we shall undertake will doubtless convince them of the necessity of conducting meteorological observations alongside their agricultural work instead of limiting themselves to those old practices which no longer correspond to the needs of science.

M. Pagnoul describes in his memoir the demonstrative experiment he made to determine the influence of light upon the development and the saccharine richness of the beet, and he calls attention to those of M. Corenwinder on the same subject. It is greatly to be regretted that he had no means for valuation of the degree of light acting upon his crops except the estimation of the proportion of sky free from clouds; this process is absolutely insufficient. We have endeavored to supply these deficiencies by actinometric data collected at Montsouris, but this is only a palliative, the clearness of the sky at Arras not being always the same as at Paris.

The documents furnished by M. Pagnoul are of two orders. One series relates to successive analyses made every ten days in 1879 with samples taken from the same plot uniformly planted; the other series relate to analyses of ten successive crops taken from the same field from 1870 to 1879 inclusive.

A primary point seems to us to follow from this great work. Beets sown April 5 came up slowly and unevenly. At Paris this month was not dry. From the 5th to the 30th March we find 17 days of rain giving 2.59 inches of water. The total amount falling during the month was, it is true, 1.8 inches at Arras; but it was still above the average (1.6 inches) of the past ten years. The bad germination of the seed cannot, therefore, be attributed either to dryness or to an excess of humidity in themselves. The month of April, 1879, was a cold one, especially from the 10th to the 30th. Its average temperature was but 45°.6 Fahr., while the average of the last ten years is 49°.6 Fahr.

Beet seed is generally sown from the 10th to the 25th of April, during which period the average temperature at Paris is 50°.36 Fahr. This period may be advanced and in the northern departments sowing is often done, in favorable years, during the last fortnight of March. We believe that more inconveniences than advantages result from sowing before the average temperature has passed 46°.4. This condition occurs at Paris as early as the 28th of March in average years, but it is far from common to all years.

On the other hand the analysis of M. Pagnoul show that from the 19th to the 25th of September, 1879, the weight of the roots and their contents of sugar showed no marked variations other than those which may be attributed to inequalities of samples, whatever may be the care observed in selecting them. At the same time, the pro-

portion of chlorides, and especially that of nitrates, shows a marked increase in the last twenty days of October. From the 21st of September, 1879, the season became, it is true, relatively dry for the year; but rains were not really wanting, either in number or in quantity. It therefore becomes a question of temperature. In fact, while the average temperature is 60°.4 and 61°.7 for the first two decades of September, 1879, it fell to 55°.5 for the third and 54°.3, 49°.1, 9°.5, and 47°.48 for the three decades of the month of October following. It therefore appears that the beet ceases to grow usefully below 55°.4. It still takes place, but its reduced assimilation scarcely compensates for its proper consumption, and even though a new growth of leaves may not intervene to reduce its content of sugar, the weight of salts it contains increases to an extent injurious to the extraction of this product. In an average year this temperature limit is attained at Paris the 19th of October; the date is advanced or retarded according to the years and the sections. We think there is no advantage in leaving the beet in the ground longer than this, while there are very decided advantages in advancing the sowing which must follow this culture. Wheat still grows in the fall as long as the average temperature does not fall below 43°.

The successive analyses of M. Pagnoul commenced the 11th of June, 1879. We find in the following table a *resumé* of these analyses made up from one given by this able chemist:

Results of analyses of beets, by M. Pagnoul.

Year 1879.	June—		July—				August—		
	11.	21.	1.	11.	21.	31.	10.	20.	30.
Rain in 10 days.....English inches..	1.29	1.45	0.71	2.20	2.28	1.02	0.31	0.94	0.71
Atmospheric heat.....degrees Fahrenheit..	600.8	611.6	606.2	568.4	617.0	604.4	642.2	647.6	638.6
Cloudiness at Arras.....	41	30	31	16	26	28	31	43	36
Clearness at Paris.....	393	479	444	399	320	378	416	361	373
Average weight—									
Of a root.....*grams..	1	7	31	105	220	346	486	666	778
Of its leaves.....do..	8	41	110	222	333	462	452	433	335
Of sugar per hectare.....†kilograms..	2	9	96	339	776	1,422	1,848	3,073	3,543
Of salts.....do....	1	4	15	49	92	144	228	275	315
Of niter.....do....	0	2	8	23	36	49	79	66	69
Relative weights for 1,000 of beets—									
Of the leaf.....	8,000	5,860	3,550	2,110	1,510	1,340	930	650	430
Of sugar.....	30	21	52	54	59	69	63	77	76
Increase of weight in 10 days—									
Of a root..... grams..	1	6	24	74	115	126	140	180	112
Of its leaf.....do....	8	33	69	112	111	129	—10	—19	—98
Of sugar per hectare.....kilograms..	2	7	87	243	437	646	426	1,225	461
Of salts.....do....	1	3	11	34	43	52	84	47	40
Of niter.....do....	0	2	6	15	13	13	30	—13	3

Year 1879.	September—			October—		
	9.	19.	29.	9.	19.	29.
Rain in 10 days.....English inches..	0.15	1.06	0.39	0.19	0.71	0.90
Atmospheric heat.....degrees Fahrenheit..	606.2	617.0	555.8	555.2	491.0	476.6
Cloudiness at Arras.....	56	34	49	25	12	26
Clearness at Paris.....	385	326	251	334	161	144
Average weight—						
Of a root.....*grams..	878	1,040	1,048	1,048	1,056	1,050
Of its leaves.....do....	312	200	126	194	98	128
Of sugar per hectare.....†kilograms..	4,320	4,655	4,691	5,068	4,727	5,002
Of salts.....do....	366	494	461	433	511	552
Of niter.....do....	86	111	107	92	146	145
Relative weights for 1,000 of beets—						
Of the leaf.....	350	190	120	180	90	120
Of sugar.....	82	75	75	81	75	79
Increase of weight in 10 days—						
Of a root.....grams..	100	162	8	0	8	—6
Of its leaf.....do....	—23	—112	—74	68	— 96	30
Of sugar per hectare.....kilograms..	786	335	36	377	—341	275
Of salts.....do....	51	120	—53	—28	78	41
Of niter.....do....	17	25	—4	—15	54	0

*1 gram = 0.022 lbs. †1 kilogram = 2.2 lbs.

The year 1879 was a cold year and one of little light. The average temperature from June to October, the duration of growth of the beet, was 59°.5 at Paris, while the average temperature is 16°.4 in a normal year. At Arras, where the summers are a little cooler than at Paris, the average was 59° instead of 59°.5. It should be noted that all the late crops were very mediocre if not bad; but in a crop grown upon a well manured and deeply plowed field, and where all the plants were well chosen and regularly separated, better results are attained than in ordinary culture. On the other hand, for comparison it is necessary to take account of the error introduced in the estimation of the quantity of the crop from results obtained with isolated samples, whatever may have been the care observed in their choice. This remark is all the more appropriate as the growth of the beet approaches completion, because the individual qualities of each root are more marked.

In 1879 the average weight of roots increased slowly at first, and until July 1 there was a period of relatively good moisture, heat, and light, but the plant was still slender and its organs of assimilation slightly developed.

Up to the 20th of July rains became almost continual. The temperature and clearness fell to a marked extent below their normal value for this season; but the leaf still developed very actively; the root enlarged as well as could be desired, and the percentage of sugar in the beet increased. This situation continued until July 30, though there was considerable diminution of the rainfalls. From July 31 to August 19 the rains without disappearing became relatively rare. It was this part of the last season during which the temperature and clearness more nearly approached the conditions of an average year. The development of leaves suddenly stopped and even became regressive; but this was at the same time the period of most rapid increase of the root and of the proportion of sugar it contained. It was about the time when the percentage of sugar in the beet attained its maximum.

If we compare the variations of weight of the roots with the quantity of water which fell, we readily recognize that there exists a relation between these two data. The variation of weight varies with the humidity of the soil without, however, being proportionate to it. Temperature acts in the same way. The percentage of sugar in the roots, like the weight of the leaves, increases rather in proportion to the degree of clearness; the coincidence is not always exact, the increase in clearness slightly preceding the increase in the proportion of sugar, and corresponding more closely with that found in the leaves which elaborate the saccharine materials deposited in the roots. It is not, therefore, from excess of water but from default of light and heat that the years of rainy summer and autumn are poor years for beets. The consequence of this is, that if in dry, hot, and light summers the fields can be irrigated in a suitable manner, the best conditions for high yield will be realized. Irrigation is undoubtedly not everywhere possible; but if growers were thoroughly convinced of its advantages it would be adopted at points where it has not yet been practiced.

There is another question quite as important, that of manures. The experimental field of M. Pagnoul was manured in the following proportions referred to the hectare,* making a strong manure.

	†Kilograms.
Barn-yard manure	20,000
Woolen waste	700
Seed-cake	1,000
Guano	300

The beets were planted at the rate of 6 per superficial meter,‡ and the yield per hectare was estimated as follows:

Sugar, per cent. of beets		7.94
Weight of beets	kilograms	63,000
Weight of sugar	do	5,002
Weight of salts	do	552
Weight of nitrate	do	145

* Hectare = 2.47 acres. † Kilogram = 2.2 pounds. ‡ Meter = 39.37 inches.

The variety cultivated was a pink beet rather rooty, smooth skin, belonging to the ordinary race of the country. The saccharine degree, 7.94, is low for extraction. In two other experimental fields, cultivated in beets without interruption for ten years, one of the fields receiving no manure, the other receiving each year a complete chemical manure, the yield for the same year, 1879, was—

	With manure.	Without manure.
Sugar of beets.....per cent..	8.3	10.0
Weight of beets per hectare.....kilos..	33,000	10,000
Weight of sugar per hectare.....do...	2,739	1,000

In these three crops the proportion of sugar increased according as the total product decreased, but it always remained low enough. In the manured field it increased to 13.9 in 1872, with the same common beets of the country, and rose to 16.7 in 1877 with an improved beet.

On the other hand, at Asnières, and under the influence of sewage water, the beets being planted at the rate of 10 per superficial meter, the yield per hectare was 80,000 kilograms of beets and 4,750 kilograms of sugar after 9 waterings made in July and August in new, sandy, and very poor ground. The crop reached 180,000 kilograms of roots and 6,640 of sugar in a soil irrigated during ten years and until the end of the season. These figures would at first seem to justify the sugar industry when it protests against the tendencies of the culture to push toward a general product by means of manures to the detriment of the industrial yield. Both interests may, however, be conciliated within the limits of reasonable conditions.

The sugar-producing power of a given surface of leaves is not undefined; it depends upon the degree of aptitude acquired by a chosen variety of beets and, undoubtedly, also upon the meteorological and other conditions which have presided at the formation of the seed employed. It also depends upon the temperature and clearness of the period of vegetation of the plants issuing from a given seed. If water and manure stimulate the development of the root in an exaggerated degree, as compared with the power of the leaves, the weight of sugar amassed in the root may increase, but it will increase in a much lower proportion than the total weight, and the saccharine content will diminish to an extent injurious to the extraction. There are, therefore, rules to be fixed either for the better preparation of the seed or for the culture of the products of this seed for the best interests of the two parties concerned. These rules are beginning to be determined by the labors of Messrs. Ladureau, Pagnoul, Corenwinder, Dehérain, but there still remain several questions to be cleared up.

It seems to be thoroughly demonstrated that sugar is primarily elaborated in the leaves under the influence of light. Outside the variety chosen, and which should be the best that can practically be procured, the greatest possible surface of leaves should be exposed to luminous action. Every ray of light which strikes the soil without being intercepted by a leaf is a lost force. Besides this, it produces a direct evaporation from the earth of a quantity of water not passing through the plant, and is a new source of loss to the latter, without the elevation of temperature that may be attributed to this nudity of soil being able to compensate for the assimilating surface which must result from it. Bare spaces in the beet field in good condition should be carefully avoided by regular planting with a separation proportional to the development to be taken by the variety to be cultivated.

Concerning water and manure, the experiments made at Asnières may furnish information that may be usefully added to that furnished by the agricultural schools or stations. It may be referred to three types. The first plot of land was submitted to no irrigation, but it had been manured in previous years by the solid deposits in the irrigation trenches from the sewage waters; the plantation was made at the rate of 10 to the superficial meter. A second parcel composed of new and very poor ground received 12 waterings with sewage waters from May 28 to August 28.

A third parcel submitted to irrigation for ten years was watered in 1879 until the time of harvesting. Samples of beets were also taken from the plain of Montrouge, the soil of which had been manured with night-soil and belonged to the dairymen of Paris. Here beets were irregularly planted.

The first series of analyses made August 8, 1879, gave the following results:

	Weight of root.	Sugar, per cent. of juice.	Total sugar, grams.
Montrouge:			
Champ Hèbert	0.342	7.27	24.8
Champ Auvray	0.460	6.67	30.7
Asnières:			
Plot I, not watered	0.508	5.30	31.7
Plot II, 7 waterings	1.035	6.59	68.2

The second series of analyses, made August 28, 1879, gave very different results:

	Weight of root.	Sugar, per cent. of juice.	Total sugar, grams.
Asnières:			
Plot I, not watered	1.056	3.68	38.9
Plot II, 12 waterings	1.562	4.53	69.7

After August 28, watering having been suspended on plot 2, the proportion of sugar rose, between August 28 to October 3, from 4.53 to 6.59; and, according to the analyses of M. Pagnoul, we should think that this increase is produced during the month of September. On the contrary, the development of the beets seems to have been entirely suspended after the close of the irrigation. In plot No. 3, where irrigation was carried on until the end of the season, the roots continued to enlarge, and on October 5, the time of harvesting, their total weight was estimated at 180,000 kilograms per hectare. But the sugar increased much less rapidly, its proportion continued to diminish and fell from 4.53, August 28, to 4.10, October 5.

An excess of nitrogenous manure, with or without watering, though favorable to the absolute weight of the crop intended for cattle food, is therefore unfavorable to the industrial employment of the plant and may render it unfit for the extraction of sugar. But its unfavorable action does not remain the same throughout the entire period of vegetation. It is in the second half of the season that it is most marked. In the first part, on the contrary, it is important that vegetation have the greatest possible activity, since then it bears principally upon the leaf, and this latter should be largely developed in order to most efficiently perform its functions. So animal manures should be incorporated in the earth in the preceding fall; chemical manures, which are rapidly assimilated, may be applied shortly before or a little after sowing or planting, but it is of no advantage to renew the application during the course of the season. This is shown in the theory and verified by the experiments of MM. Ladureau, Corenwinder, Deherain, and others. The same is true for irrigation with sewage water or even with pure water where this is possible. The first are useful and may be abundant during the first months, but they should be very moderate during the later ones if forage beets are not to be exclusively produced.

We shall ultimately examine in a meteorological point of view the results of beet-root culture during the past ten years.

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